

THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

spring 2016

FLYING BOAT

Identified in Kaneohe Bay Provides Clues to

JAPANESE ATTACK

Underwater Archaeologists Record
Submerged Historic Resources
at MCB Hawaii



NAVY
EARTH DAY
POSTER
INSIDE!

Secretary of the Navy Launches Great Green Fleet
Biofouling Remediation Equals Higher Speed, Lower Drag
Marine Corps Sponsors Study to Better Understand Energy Use



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**Chief of Naval Operations
Energy and Environmental Readiness Division**

DIRECTOR

Rear Admiral Douglas G. Morton

ACTING DEPUTY DIRECTOR

Dr. Frank Stone

DIRECTOR, COMMUNICATION AND OUTREACH

Kenneth Hess

kenneth.hess@navy.mil

703-695-5077

Currents Staff

MANAGING EDITOR

Bruce McCaffrey

Bruce McCaffrey Consulting, Inc.

brucemccaffrey@sbcglobal.net

773-376-6200

CONTRIBUTING WRITER

Kathy Kelley

ART DIRECTOR

Victoria Bermel

GRAPHIC ARTIST

Amy Jungers

DISTRIBUTION MANAGER

Lorraine Wass

ljwass@outlook.com

207-384-5249



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Marine Corps Base Hawaii cultural resource managers and underwater archaeologists are playing a critical role in preserving and documenting sunken seaplanes decimated by the Japanese during a December 1941 attack in Kaneohe Bay.

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N45 Outlook

THANK YOU FOR taking the time to read this issue of *Currents* magazine. In each issue we do our best to highlight the exceptional work and the positive impacts made by our Navy's energy and environmental stewards. Our collective stewardship of the environment and the energy resources entrusted to us enables our Navy to train and make ready our forces in the most realistic conditions possible. A ready force ensures that our Navy can project power anywhere and anytime our Nation calls on us.



I recently was hosted by USS Dwight D. Eisenhower (CVN 69) for a short embark with some of our key environmental stakeholders outside of the Department of Defense. From the Skipper, Captain Paul Spedero, to the junior Sailors in the trash room, all hands impressed our visitors with their knowledge of and their commitment to the environment. They also did a superb job of explaining and demonstrating why realistic training is essential to mission success. I have had similar experiences in recent months on the USS Barry (DDG 52) and the USS Philippine Sea (CG 58)—great Sailors sharing the best of our Navy with those we serve and defend.

What I have witnessed across the Navy during my short time as director of the Energy and Environmental Readiness Division is a dedicated team collaborating on weighty, complex issues to ensure the readiness of our Navy. You should all be proud of your efforts to balance the needs of the Navy with the concerns of our stakeholders. We must also continue to listen to the voices of those who may not understand our mission and be ready to explain and inform until the highest need is met. Our stewardship requires nothing less. ⚓

Rear Admiral Doug Morton
Director, Chief of Naval Operations Energy and Environmental Readiness Division



Rear Admiral Morton (N45), Mr. Karnig Ohannessian (Deputy Assistant Secretary of the Navy for Environment) and environmental regulators gather on the flight deck of USS Dwight D. Eisenhower (CVN 69) during an embark on 2–3 April.



FLYING BOAT

Identified in Kaneohe Bay Provides Clues to
JAPANESE ATTACK



Underwater Archaeologists Record Submerged Historic Resources at MCB Hawaii

Marine Corps
Base (MCB)
Hawaii cultural resource
managers and under-
water archaeologists
are playing a critical
role in preserving and
documenting sunken
seaplanes decimated by
the Japanese during a
December 1941 attack
in Kaneohe Bay.

*Historical photo sources: World War II Database
and Naval History and Heritage Command*



On this Sunday morning, the Japanese attacked NAS Kaneohe *MINUTES BEFORE* the attack on Pearl Harbor.

JAPANESE ATTACK ON NAS KANEOHE

Sunday morning, 7 December 1941 began as most Sunday mornings at Naval Air Station (NAS) Kaneohe. This small seaplane base on the east (windward) side of Oahu Island was affectionately dubbed the Country Club of the Pacific. The base was constructed on a peninsula of land called Mokapu. Although the north shore of the peninsula features large crescent shaped waves perfect for surfing, the southern shore faces Kaneohe Bay, a protected body of water used as a water runway by seaplanes or flying boats—Catalina PBY (“PB” for patrol bomber and “Y” for the code assigned to Consolidated Aircraft Corporation—the manufacturer). Three PBY squadrons (VP-11, VP-12, and VP-14), all part of Patrol Wing 1, were stationed at NAS Kaneohe.

On this Sunday morning, however, the Japanese attacked NAS Kaneohe (now MCB Hawaii) minutes before the attack on Pearl Harbor. It started with two strafing runs over NAS Kaneohe during which time Japanese gunners fired upon Navy personnel and planes. In the After Action Report, Commanding Officer of NAS Kaneohe, Harold M. Martin wrote, “At about 0750 Sunday, 7 December, low-flying planes were noted passing over the station. Immediately thereafter the sound of machine gun fire alarmed the station and reports began to flow in that Japanese planes were

obviously using incendiary bullets as fires were started immediately. Most of the casualties from this attack were on the planes moored in the water...”

Only three PBYs from VP-14 escaped destruction because they were on dawn patrol over Pearl Harbor. One plane, however, received enemy fire and managed to return to base, in a condition described by Commander Karig, as “badly shot up in aerial combat.” The other PBYs were at NAS Kaneohe during the attack. These PBYs were high priority targets for the Japanese since they were long-range patrol bombers that could have followed the Japanese attack

planes back to their carriers. During the attack, four or five PBYs were undergoing repair in Hangar 1 and between 23 and 25 were parked on the ramps, which suggests that three to six were moored in Kaneohe Bay.

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Location of MCB Hawaii on the island of Oahu.
Map Data ©2016 Google



THE BASICS ABOUT THE PBV "FLYING BOAT"

The PBV was one of the most versatile aircraft used during World War II. PBVs were able to conduct surveillance and reconnaissance patrols, bombing raids, air to sea rescues, evacuations, and ferry troops and supplies. These aircraft were considered "flying boats" since they landed and took off from the water; they were designed to land directly on their fuselage and not on floats like seaplanes. Although seaplanes were initially

employed during World War I, it was not until Consolidated Aircraft Corporation started experimenting with seaplane designs in the 1930s that the PBV was developed. The first PBV-1, originally called a KP3V-1, was constructed in 1936 and would become the most successfully produced flying boat in U.S. military history.

The first design of the PBV included a high wing, an all metal monoplane with struts attached to the wing, floats, and an open cockpit. It weighed about 12,500 pounds and had a range of 1,500 miles. Later improvements to the plane included an enclosed cockpit, retractable floats on the wing tips, and a semi-cantilever wing. The wing itself was constructed of an aluminum alloy frame that was covered with metal forward of the rear span and fabric aft of the span. The early versions of the PBV had beaching gear that the beach crew would have to attach

after landing to bring it ashore rather than attached wheels. The PBV-5, which was the aircraft at NAS Kaneohe in 1941, had additional changes, including waist gun blisters that were armed with .50 caliber machine guns, a redesigned tail with a squared off rudder and horizontal stabilizers and elevators. Also, new Hamilton Standard Hydromatic propellers were installed. The PBV could carry four 500-pound bombs, a torpedo on racks under the wings, or four depth charges.

The PBV flight crew consisted of two pilots, a navigator, a radioman, a flight engineer, a bombardier/bow gunner and two waist gunners. The plane contained crew comforts for long distance flights, such as bunks, a galley, and food and water stores.

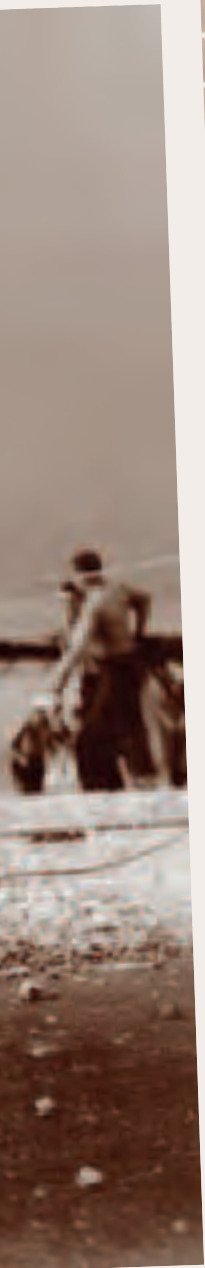




Attempting to save a burning PBV at NAS Kaneohe after the Japanese attack on 7 December 1941.
Navy Historical Center

Following the attack, *MYSTERY HAS SURROUNDED* the fate of the PBVs moored in the bay.

CONTINUED FROM PAGE 7



The first wave of the Japanese attack lasted only eight minutes and every exposed PBV at NAS Kaneohe was damaged. Chief Petty Officer Charles Clark, who was on security watch, remembered a burning PBV on the water off Hangars 1 and 2. This sight he never forgot while he stood there formulating the grim realization that his base was under attack. Daniel Griffin, an enlisted pilot, swam out to his plane, which was moored in the bay. "He just barely got airborne," recounted his son Don Griffin, when "it got hit and burst into flames." Photo documentation indicates that Sailors working by the ramp attempted to pull burning PBVs from the bay to possibly repair them or retrieve the guns from the planes. About 25 minutes after the first attack, another squadron of Japanese Zeros (fighter planes) appeared and began firing on the planes and dropping 100-pound bombs.

Eighteen Sailors and two civilians were killed, and 69 others were injured. Of the 33 planes on the ground, including possibly six floating just offshore, 27 were put out of commission, and the remaining sustained serious damage. Three Japanese fighter planes were shot down, one at the base of Puu Hawaii Loa and two in Kailua Bay.

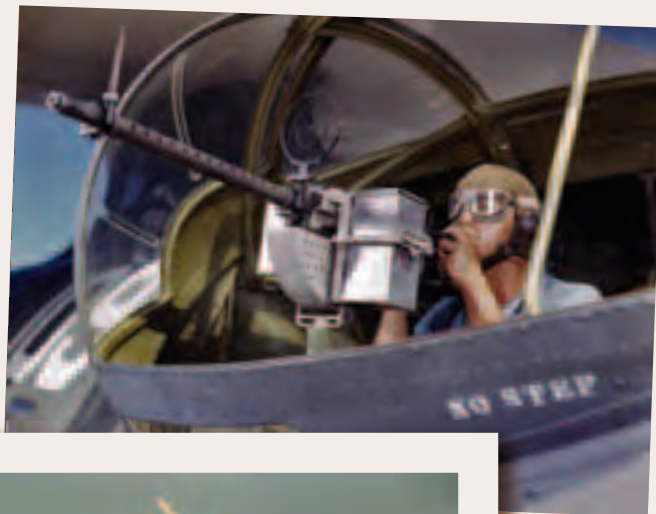
THE FATE OF PBVs MOORED IN KANEOHE BAY

Following the attack, mystery has surrounded the fate of the PBVs moored in the bay. It has been assumed that pilots of several planes attempted to detach from their mooring buoys and take off. As indicated from oral testimony, at least one plane was burning and may have drifted out into the bay before sinking. It is possible that some of the PBVs were pulled ashore and salvaged for parts. Other planes may have sunk on their moorings.

Historians have disagreed over which planes were at NAS Kaneohe and

what happened to the planes after the attack. In addition, families, such as the Griffin family, have wanted to know the locations of the submerged PBVs flown by loved ones.

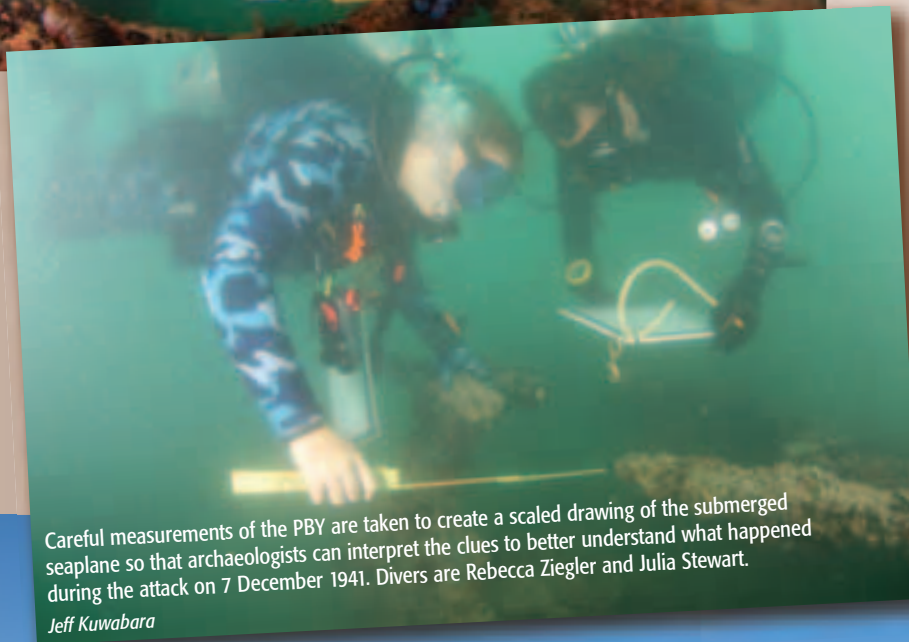
Underwater archaeologists from East Carolina University, the University of Hawaii, and the National Park Service





Underwater archaeology student, Rebecca Ziegler, photo documents details of the submerged PBV in the waters off of MCB Hawaii.

Jeff Kuwabara



Careful measurements of the PBV are taken to create a scaled drawing of the submerged seaplane so that archaeologists can interpret the clues to better understand what happened during the attack on 7 December 1941. Divers are Rebecca Ziegler and Julia Stewart.

Jeff Kuwabara

became interested in these questions in the early 1990s after U.S. Marine Corps divers from MCB Hawaii identified remains of an airplane in the installation's offshore waters. Initial reconnaissance of the aircraft debris in 1994 confirmed that the wreckage was from a PBV lying on the silt floor of the bay in 25 feet of water about 500 feet from shore. Examination of the wreckage revealed that the PBV is positioned in an east-southeast direction and consists of a section of a fuselage and wing lying at an oblique angle to one another, accounting for 53 feet of the original 104-foot wingspan of the aircraft. In addition, a portion of the plane's tail was located southwest of the main wreckage, possibly having been blown apart

Overview of MCB Hawaii showing Kaneohe Bay on the right (north and west) side of Mokapu Peninsula and Kailua Bay on the left (south) side.

Raymond Rippe



This PBY has the same type of significance as the USS Arizona and USS Utah; they are all **DIRECT CASUALTIES** of the December 7th attack. —Dr. Hans Van Tilburg

from the body of the plane. No paintings, markings, or identification were discernable. A significant finding during this study was a submerged buoy located near the wing and fuselage that still held air. The buoy consists of an elongated sphere approximately 18 inches in diameter constructed of rubber-coated metal; it resembles the description of the buoys used in moorings for the PBYs. A steel cable, partly buried below the plane, appears to attach to both the buoy and a large rectangular piece of concrete used as a mooring anchor block. The steel cable provides compelling evidence that the PBY sank at its mooring, ruling out speculation that the plane crashed or represented discarded wreckage.

Extensive examination of the PBY indicates that the PBY does not have a wheel well and is thus an early model of the PBY before retractable wheels were added to the planes. This type of PBY, known as a PBY type 5, is consistent with known planes stationed at NAS Kaneohe during the attack. Diving on the interior of the cockpit, archaeologists observed that the cockpit controls for the port side engine are located in the “throttled up” position. PBY pilots started the port engine first to allow the plane to idle up to its anchor buoy for release.

Underwater archaeologists also identified substantial damage to the port side of the fuselage and wing, possibly having originated from inside the plane. They hypothesized that a depth

charge triggered by a fire, may have caused this catastrophic damage while the PBY was throttling towards the buoy and caused the plane to rapidly sink. A jagged rip in the aluminum can be seen behind the navigator’s window and resembles damage caused when a propeller detaches and tears into the fuselage. The underwater archaeologists from the survey in 1994 noted that “this PBY 5 was doubtless one of the first planes to be strafed by the Japanese fighter planes and probably caught fire within minutes of the attack...It is not beyond reason to speculate that this particular plane’s crew was on station and were in the process of starting the port engine when the attack commenced.”

FAST FORWARD 20 YEARS

More than 20 years have passed since underwater archaeologists initially recorded the PBY in Kaneohe Bay and almost 75 years since the Japanese attack. Dr. Hans Van Tilburg, who was on the initial project and is now the maritime heritage coordinator with the National Oceanographic and Atmospheric Administration’s (NOAA) Office of National Marine Sanctuaries, continues to be awed by this submerged plane. He conveys the significance of this underwater archaeological site when he says, “This PBY, known by few and seen by even fewer, has the same type of significance

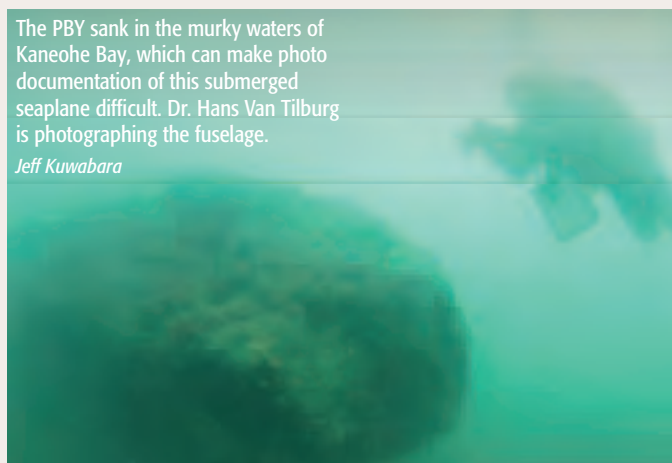
as the USS Arizona and USS Utah; they are all direct casualties of the December 7th attack.”

The PBY’s location in the restricted waters of MCB Hawaii has aided in its protection. Since this important historic site is located in MCB Hawaii’s waters, it falls to the base’s Cultural Resources Managers, June Cleghorn and Coral Rasmussen, to oversee the preservation and documentation of the PBY. Discussions with Dr. Van Tilburg led to speculation about the overall stability of the plane and whether additional information can be gathered using improved photographic technologies.

By partnering with NOAA and the University of Hawaii, MCB Hawaii assembled a team of scientific divers to document site changes of this plane, identified as one of America’s first casualties of the war, that have occurred over the last 21 years. This site, hidden under tranquil blue waters, lies relatively undisturbed.

The PBY sank in the murky waters of Kaneohe Bay, which can make photo documentation of this submerged seaplane difficult. Dr. Hans Van Tilburg is photographing the fuselage.

Jeff Kuwabara



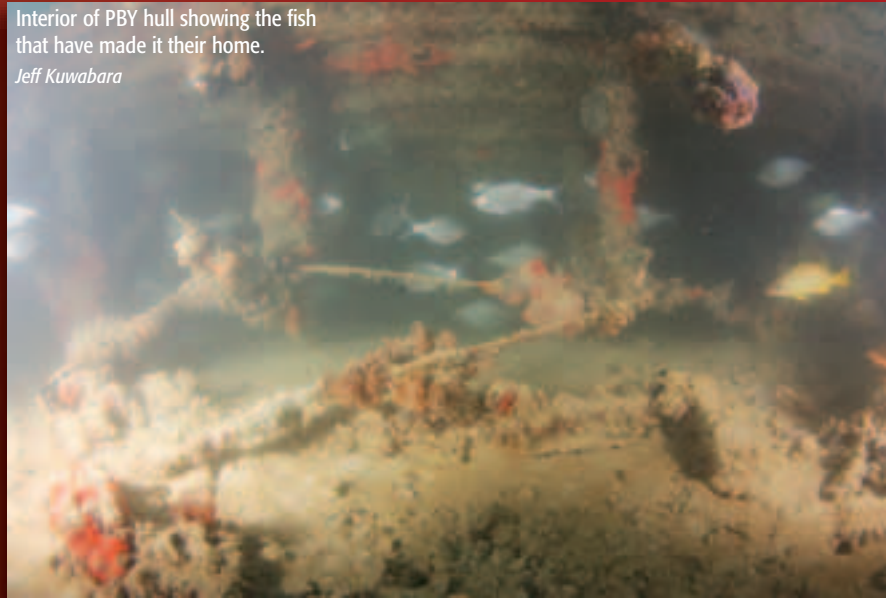
THE BASICS ABOUT THE SUNKEN MILITARY CRAFT ACT

The Sunken Military Craft Act (SMCA) was enacted on October 28, 2004. Its primary purpose is to preserve and protect from unauthorized disturbance all sunken military craft that are owned by the United States government, as well as foreign sunken military craft that lie within U.S. waters. Pursuant to the SMCA, the Navy's sunken military craft remain property of the U.S. regardless of their location or the passage of time and may not be disturbed without permission from the U.S. Navy.

The Naval History and Heritage Command (NHHC) Underwater Archaeology Branch manages the Navy's more than 17,000 ship and aircraft wrecks located around the world. These craft, and their associated contents, represent a collection of non-renewable and significant historical resources that often serve as war graves, carry unexploded ordnance, and contain oil or other hazardous materials. Accordingly, it is the overall policy of the U.S. Navy that its sunken military craft remain in place and undisturbed.

Interior of PBV hull showing the fish that have made it their home.

Jeff Kuwabara



Detail of the engine nacelle, an aerodynamic structure that holds the engine, on the starboard wing. Note the coral growing on the hard substrate of the plane.

Jeff Kuwabara

The U.S. Navy is in the process of establishing a revised permitting program to allow for controlled site disturbance of sunken and terrestrial military craft for archaeological, historical, or educational purposes. In the interim, applications are submitted for consideration under the current permitting program. The SMCA does not affect commercial fishing and laying of submarine cables, non-intrusive recreational diving, salvage of vessels that do not qualify as sunken military craft, and the routine operation of ships.

For more information, visit www.history.navy.mil/research/underwater-archaeology/policy-and-resource-management/sunken-military-craft-act.html.

Discovery of additional **PBY LOCATIONS** can help confirm how many PBYs were moored in the bay and what each plane was doing at the time of the attack.

During the summer of 2015, underwater archaeologists, led by Dr. Tilburg, slide off the dive boat and into the water to inspect the plane. Curious fish accompany the archaeologists as they swim towards the submerged PBY, initially visible only as a dark shadow in the green-blue water. First they see the form of the damaged fuselage, followed by the wing and engine nacelle. With the aid of improved underwater cameras, these images were captured, showing details of the plane never seen before. June Cleghorn, Senior Cultural Resources Manager at MCB Hawaii, explains why, as the 75th anniversary of the attack approaches, these images of the wreck are important,

“This sunken flying boat is a window into the events of the attack, a moment in time which reshaped the Pacific region. Understanding this site sheds light on the mystery of the lost PBYs, and honors the legacy of the Navy and Marine Corps Base in Hawaii.” The PBY-5 wreck is protected by the SMCA of 2014.

Dr. Van Tilburg noted that although the site has remained relatively stable with most of the major features remaining in place and apparently undisturbed, the PBY is deteriorating due to natural elements. There is an increased deterioration on the hull and wing duraluminum (age-hardenable aluminum

alloy) and metal over the starboard engine nacelle system.

WHAT'S NEXT

Mystery still surrounds the disposition of the remaining PBYs moored on the water the morning of 7 December 1941. MCB Hawaii plans to continue partnering with NOAA and the University of Hawaii to search Kaneohe Bay. Technological advances in magnetometers, which measure the total magnetic strength of materials, can be used to survey the ocean floor and discover remnants of the PBYs that may not be immediately recognizable or buried under the soft silt of the bay floor. Discovery of additional PBY locations can help

confirm how many PBYs were moored in the bay and what each plane was doing at the time of the attack. Although this information is helpful to historians, it is very important to family members that continue to mourn the loss of their loved ones. The PBY already discovered, as well as others that may be present in Kaneohe Bay, will continue to be protected and preserved at the bottom of a those that fought bravely on 7 December 1941, and as such, will eventually succumb to the environment. ⚓

Underwater archaeology students preparing for a dive on the submerged PBY in Kaneohe Bay.

Jeff Kuwabara



Coral Rasmussen
Marine Corps Base Hawaii
808-257-7134
DSN: 457-7134
coral.rasmussen@usmc.mil



Secretary of the Navy Launches Great Green Fleet

Year-long Initiative Kicks Off in San Diego

ON JANUARY 20, ships from the USS John C. Stennis Carrier Strike Group sailed out of Naval Air Station (NAS) North Island, San Diego on alternative fuel—the carrier itself traveling on nuclear power as usual, and vessels from the strike group on an advanced biofuel blend. The ships and aircraft will also use energy efficient technologies and/or practices during this deployment. The event was the official launch of the Great Green Fleet—the second half of a key energy goal established by Secretary of the Navy (SECNAV) Ray Mabus back in 2009.

Guided-missile destroyer USS Stockdale (DDG 106) and the aircraft carrier USS John C. Stennis (CVN 74) served as the backdrop for the kickoff ceremony, where Secretary Mabus delivered remarks alongside U.S. Department of Agriculture (USDA) Secretary Tom Vilsack; Vice Adm. Mike Shoemaker, Commander, Naval Air Forces, Pacific;

Congresswoman Susan Davis (D-CA) and Congressman Scott Peters (D-CA). Deputy Under Secretary of the Navy Tom Hicks; Assistant Secretary of the Navy (Energy, Installations and Environment) Dennis McGinn; and Deputy Assistant Secretary of the Navy (Energy) Joe Bryan also attended the ceremony.

Secretary Mabus reflected on the progression of energy sources throughout U.S. naval history during his remarks. “The Navy has always been a leader when it comes to energy innovation,” said Mabus. “From sail to coal in the middle of the 19th century, from coal to oil in the early 20th century, to pioneering the use of nuclear in the middle of the 21st century.”

Mabus related this history of energy advances to the operating environment of naval forces. “Sailors look out, they look to the horizon. They see no obstacles. They see the open sea,” he said.

As the U.S. ambassador to Saudi Arabia from 1994–1996, Mabus had noted with concern that the U.S. military is highly dependent on foreign oil. Upon assuming his position as Secretary of the Navy in 2009, he sought to reduce that dependence by diversifying energy sources and lowering energy consumption across the Department.

“When it comes to power, my focus has been about one thing and one thing only—better warfighting,” Mabus remarked. “The Great Green Fleet shows how we are transforming our energy use to make us better warfighters, to go farther, stay longer and deliver more firepower. In short, to enable us to provide the global presence that is our mission.”

Secretary Vilsack stated that the feedstock for the biofuel to be used during this most recent launch of the Great Green Fleet was provided by Midwestern farmers and ranchers,

When it comes to power, my focus has been about one thing and one thing only—better warfighting.

—Secretary of the Navy Ray Mabus



supporting rural America and the nation's agricultural economy.

"Today's deployment proves that America is on its way to a secure, clean energy future, where both defense and commercial transportation can be fueled by our own hard-working farmers and ranchers, reduce landfill waste, and bring manufacturing jobs back to rural America," said Vilsack. He pointed out that rural America comprises 15 percent of the nation's population, yet nearly 40 percent of armed service members originate from this region.

Technologies & Energy-related Programs on Display

Just a few yards from the ceremonial stage, exhibits on the NAS North Island pier showcased energy projects and systems that are in use within the Navy and Marine Corps and which support the SECNAV's energy goals. Event participants and reporters toured the exhibits and asked questions about the technologies.

The Navy Expeditionary Combat Command set up tents with energy-efficient linings, a high-efficiency generator, and light emitting diode

(LED) lighting, and also offered tours of a global positioning system-assisted bulldozer that reduces time and fuel expended for grading functions in the field. The Chief of Naval Operations Energy and Environmental Readiness Division (OPNAV N45) display showed samples of algae, camelina, and animal fat-based biofuels; the Energy Warrior app and video content; and a tabletop solar charging station.

The U.S. Fleet Forces Command display featured information about shipboard and aviation energy conservation measures, as well as an interac-

The Basics About Secretary of the Navy Ray Mabus

THE HONORABLE RAY Mabus is the longest serving Secretary of the Navy since World War I. Secretary Mabus announced his vision for the Great Green Fleet in 2009 as one of five aggressive energy goals:

- 1. Increase Alternative Energy Use Department of the Navy (DoN)-Wide**
By 2020, 50 percent of total energy consumption will come from alternative sources.
- 2. Increase Alternative Energy Ashore**
By 2020, DoN will produce at least 50 percent of shore-based energy requirements from alternative sources; 50 percent of Navy and Marine Corps installations will be net-zero.
- 3. Sail the "Great Green Fleet"**
DoN will demonstrate a Green Strike Group in local operations by 2012 and sail it by 2016.
- 4. Reduce Non-Tactical Petroleum Use**
By 2015, DoN will reduce petroleum use in the commercial fleet by 50 percent.
- 5. Energy Efficient Acquisition**
Evaluation of energy factors will be mandatory when awarding DoN contracts for systems and buildings.

Secretary Mabus selected the name "Great Green Fleet" as homage to President Theodore Roosevelt's Great White Fleet, which positioned the United States as a global force at the turn of the 20th century. The Great Green Fleet will usher in the next era of DoN energy innovation.

During his tenure, Secretary Mabus has emphasized four priorities to enable the Navy's global posture—People, Platforms, Power and Partnerships, in addition to his energy goals which fall under the Power priority but also enable the other three. Under his leadership, the Navy has reduced oil consumption by 15 percent and the Marine Corps has reduced its use of petroleum by 60 percent since 2009. Ashore, the Navy successfully procured 1.1 gigawatts of renewable energy for its shore facilities, five years earlier than its intended target.





Aviation Energy Operational Procedures

NAVAL AIRCRAFT ARE not presently equipped with new technologies to conserve fuel, but there are numerous procedures and best practices at the disposal of pilots and aircrews that can optimize fuel use and extend flying time.

- Short Cycle Mission and Recovery Tanking which can save fuel burned by aircraft tankers during refueling missions
- Flying based on maximum range profile
- Truck refueling for fixed-wing aircraft training
- Optimum climb and continuous descent flight profile
- Less than all-engine taxi
- Minimizing auxiliary power unit use

The naval aviation community is also revising mission tracking software and data logging approaches to better capture fuel use. In addition, all naval aircraft have been certified to use advanced fuel blends of up to 50 percent biofuel when those fuels are available.

tive kiosk and print handouts explaining their “Stewards of the Sea” outreach program.

The Navy Region Southwest exhibit focused on energy-related shore installation management activities at Naval Base Coronado, Naval Base San Diego, Naval Air Station Lemoore, and elsewhere within the region.

Representatives from the Army and the Marine Corps Expeditionary Energy Office (E2O) demonstrated field-portable GREENS and SPACES solar power systems as well as the Joint Infantry Company Prototype (JIC-P)—a kinetic energy harvesting system consisting of a backpack and knee brace for dismounted troops.

Biofuel At Sea Replenishment of USS William P. Lawrence

Following the official remarks and a brief media availability with reporters on the pier, Mabus and Vilsack boarded an MH-60S Seahawk helicopter from Helicopter Sea Combat Squadron (HSC) 14 and flew out to USS William P. Lawrence (DDG 110) at sea to witness the underway replenishment of the Lawrence with a biofuel blend by replenishment oiler USNS Guadalupe (T-AO 200). The Secretaries also toured energy conservation measures aboard the destroyer, which include LED lighting, a stern flap, and a shipboard energy dashboard.

USS William P. Lawrence commanding officer Cdr. Walter C. Mainor underscored the benefit of these initiatives, stating, “As a whole, these energy saving measures allow us to be on station longer and to do our job better. The Navy has been at the forefront of energy innovation.”

The surface combatant ships which received biofuel in the kickoff event timeframe included USS William P. Lawrence, USS Stockdale, USS Coronado (LCS 4) and USS Mobile Bay (CG 53). The biofuel was a drop-in replacement blend of 10 percent fuel derived from waste beef fat and 90 percent conventional marine diesel fuel (F-76).

Navy Requirements & Cost-Competitive Biofuel

To meet the Navy’s requirements, alternative fuels must meet all military fuel specifications and function as drop-in replacements. That means the fuels can be mixed in the same tank as petroleum-based fuels, and do not require modifications to existing engines or transport and delivery systems. Feedstocks for the alternative fuels tested and used by the Navy to date have included algae, camelina (a



Vice Adm. Mike Shoemaker (left), USDA Secretary Tom Vilsack (center), and SECNAV Ray Mabus (right) stand for the national anthem at the commencement of the Great Green Fleet launch.

Madeline Joyce



relative of the mustard seed), animal fat, and renewable isobutanol. These types of feedstocks are advantageous because they do not compete with food crops.

By law and current policy directives, the Defense Logistics Agency (DLA) and the Navy can only purchase operational quantities of advanced biofuels if they are cost competitive with petroleum-based fuel. In 2015, DLA awarded a contract for 77.6 million gallons of an advanced biofuel blend derived from waste beef fat (10 percent) and conventional petroleum (90 percent) under its Rocky Mountain West Coast bulk fuel solicitation. This is one of four major fuel solicitations DLA uses to supply the Navy with fuel worldwide annually. DLA awarded the contract to California-based producer Alt Air Fuels at the price of \$2.05 per gallon for the fuel blend. Through the Commodity Credit Corporation, USDA contributed approximately \$0.14 per gallon, helping to reach the \$2.05 price and supporting the Midwest farmers and ranchers who supplied the beef fat feedstock. This price is comparable to the price of conventional F-76 fuel.

Shipboard Energy Conservation Measures

During 2016 and beyond, U.S. Navy ships will use energy conservation measures (ECM) to optimize their energy use and get the maximum mission capability out of every

gallon of fuel. ECM technologies currently in use on some Navy ships include the following:

- **Solid State Lighting**
LEDs consume approximately half the energy and last five times longer compared to conventional bulbs.
- **Stern Flaps**
An extension that modifies the water flow under a ship's hull, reducing drag and yielding greater fuel efficiency.
- **Shipboard Energy Dashboard**
A system that provides real-time situational awareness of energy supply and demand.
- **Thermal Management Control System**
Smart programmable thermostats and a centralized control unit provide efficient heating and cooling for each individual compartment throughout a ship.
- **Propeller/Hull Coating**
Spray-on surface that reduces corrosion and accumulation of biofouling organisms that create drag.
- **Combustion Trim Loop**
Electronic controls which optimize fuel/air mixture to improve boiler efficiency and reduce fuel consumption.



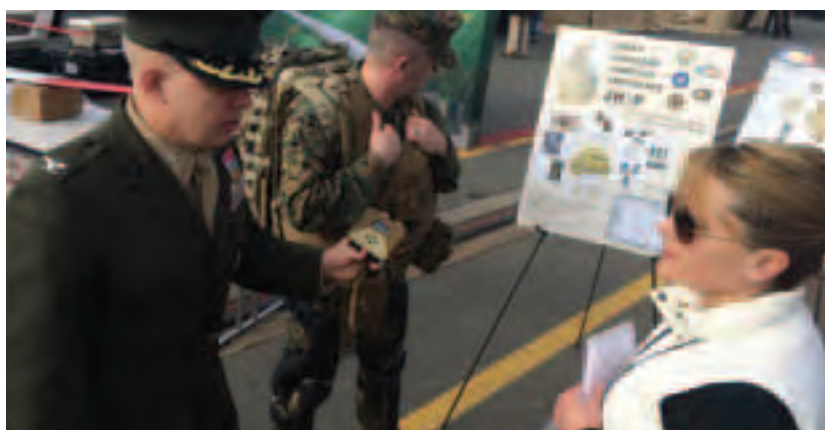
Capt. Brian Weiss from the Fleet Readiness and Logistics (OPNAV N4) Reserve Unit, poses for a photograph with samples of advanced biofuels.

Madeline Joyce



USDA Secretary Tom Vilsack and SECNAV Ray Mabus field questions from reporters at the conclusion of the Great Green Fleet launch ceremony.

Kenneth Hess



Col. Jim Caley, Director of the Marine Corps E2O explains Marine Corps expeditionary systems to reporter Jeanette Steele, San Diego Union-Tribune while Capt. Anthony Ripley demonstrates the JIC-P in the background.

Kenneth Hess



SECNAV Ray Mabus and USDA Secretary Tom Vilsack speak to media aboard the guided-missile destroyer USS William P. Lawrence. Mabus and Vilsack flew out to William P. Lawrence to witness it replenishing its tanks with alternative fuel, made from waste beef fat, from the fleet replenishment oiler USNS Guadalupe.

MCS2 Armando Gonzales

During the launch of the Great Green Fleet 2016, Navy and Marine Corps representatives fielded questions from the press and event participants, and posed for photos for national and local media outlets. Media coverage ranged from local San Diego television and print outlets to national outlet coverage by the Associated Press and Reuters.

Navy ships also use operational procedures to conserve fuel:

■ Trail Shaft

One of two propeller shafts spinning without power, with the pitch set to minimize drag.

■ Autopilot

Used during transits to efficiently adjust for weather, sea state, currents and other factors.

■ Minimize Use of Bleed Air System

Hot air flow from gas turbines can be used for functions such as de-icing and noise reduction, but this affects fuel economy.

■ Drift Operations

Securing ship engine propulsion and taking advantage of ocean currents to move through the water.

■ Duty Radar Power Reduction

When two or more Aegis radar-equipped ships are operating in the same area, one ship can sometimes operate in low power or standby mode.

■ Low Power SPY Radar Operation

Operating SPY radar at low power when tactically prudent.

In addition, Sailors receive training on best practices for conserving energy aboard ships, such as using efficient power plant configurations ("lineups"), turning off unnecessary shipboard equipment, maintaining air conditioning boundaries, and taking short "Navy" showers to conserve water.



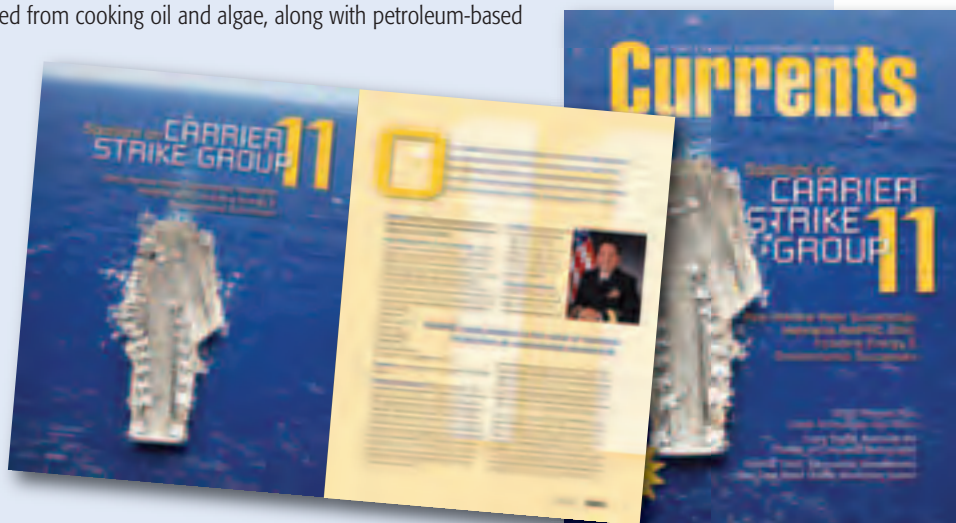
Rim of the Pacific 2012

AS THE FIRST part of SECNAV's Great Green Fleet goal, the Navy conducted a biofuel demonstration during the Rim of the Pacific (RIMPAC) exercise on July 19-20, 2012. Ships and aircraft training with Carrier Strike Group 11 operated on 50/50 blends of advanced biofuel derived from cooking oil and algae, along with petroleum-based fuel. They also showcased energy efficient technologies and practices. Participating ships and aircraft in the demonstration included:

- USS Chafee (DDG 90)
- USS Chung Hoon (DDG 93)
- USS Princeton (CG 59)
- USNS Henry J Kaiser (T-AO 187)
- Carrier Air Wing ELEVEN

In contrast, the Great Green Fleet launch in January 2016 included a biofuel blend for surface ships but only conventional fuel for the aircraft. Additional fuel purchases this year may include biofuel for ships and aircraft, depending on cost and availability.

For more information on RIMPAC 2012, see the fall 2012 issue of *Currents* at <http://greenfleet.dodlive.mil/currents-magazine/currents-magazine-2012/currents-fall-2012>.



SECNAV Ray Mabius receives a fuel sample of alternative fuel from Gas Turbine Systems Technician (Mechanical) 3rd Class Shalen Shivers while aboard the guided-missile destroyer USS William P. Lawrence.
MCS2 Armando Gonzales

After the Event

After the event, Mr. McGinn noted the significance of the Great Green Fleet deployment and its implications for future operations. "The launch of the Great Green Fleet marks a milestone for Navy and Marine Corps and sets a "new normal" for leveraging energy in our daily operations. The incorporation of energy efficient technologies and practices, and alternative fuels into our missions is a significant step toward increasing combat capability, enhancing operational flexibility, and eliminating vulnerabilities for our Sailors and Marines," said McGinn.

Throughout 2016, other DoN ships, aircraft, amphibious and expeditionary forces, and shore facilities will highlight energy efficient technologies and practices, as well as alternative fuel use, as part of the Great Green Fleet as they perform their planned missions worldwide. ⚓

Kenneth Hess
Chief of Naval Operations Energy and
Environmental Readiness Division
703-695-5077
DSN: 225-5077
kenneth.hess@navy.mil

Madeline Joyce
Chief of Naval Operations Energy and
Environmental Readiness Division
703-695-5073
DSN: 225-5073
madeline.joyce.ctr@navy.mil



ENERGY WARRIOR PROFILE

GSE2 CRYSTAL MORRISON



GAS TURBINE SYSTEM
TECHNICIAN (ELECTRICAL)
USS MAKIN ISLAND (LHD 8)



I believe information learned should be passed on to our new Sailors. Because in the end, our new Sailors are the future and this new technology is what they're going to be working on."

Q: WHAT IS YOUR JOB ON BOARD USS MAKIN ISLAND?

I've been an electrician on board USS Makin Island for almost four years now. I arrived at the beginning of our first deployment, our maiden voyage, so overall I've done two deployments. My main responsibility is to make sure all of our electrical supply is effectively distributed throughout the ship. In fact, my team and I are responsible for the generator and all things related to its upkeep and maintenance. Basically, if there are any issues with it, it's our job to get in there and check it out—we troubleshoot a lot. We control the 4,160-volt air conditioning system, which is unique to our ship and essentially a really big generator, as well as the transformers, switchboards, and other electrical systems. I really enjoy working on this type equipment and take pride in my job. Not everyone gets to say they actually work with a 4,160-volt system.

Q: WHAT IS THE BEST PART OF YOUR JOB?

When we are on deployment and something goes wrong or something breaks, it's up to my team and I to fix it. Luckily, for us, we like troubleshooting. It's a good challenge and once you've actually solved the problem, you always get a sense of accomplishment. I like being part of the bigger picture, helping our command stay mission ready. So that's why I always work hard and do my best. I like being able to say, "Yes! We are back on track and mission ready!"



ENERGY EFFICIENCY INCREASES



Q: WHAT DO SAILORS NEED TO KNOW ABOUT MAKIN ISLAND'S HYBRID ELECTRIC DRIVE?

The ship's hybrid electric drive (HED) is designed to run on our auxiliary propulsion motors at low speeds and on our gas turbine engines at higher speeds. Our HED not only saves energy and money but it's also a really great technology to get familiar with. It's good training. This technology is definitely the future and I think the more people who learn how to use it, the better off our Navy will be. It's definitely going to give us into a brighter future and make our nation stronger.

Q: WHY IS THE HED SO IMPORTANT TO THE NAVY MISSION?

There are numerous advantages to having the HEDs implemented throughout the fleet. But the most important one, I think, is that it allows us to stay on station longer. While deployed and because of the HED, we didn't have to break away from our mission as often to undergo at-sea refueling since we consumed less fuel—it allowed us to be mission ready. Being energy efficient is definitely something we all need to focus on.

Q: WHAT MOTIVATES YOU?

I am getting my degree in electrical engineering, so this is a field that I actually enjoy. My main motivation is that I enjoy learning new things. No matter what the situation is, even if it's something as simple as changing out a light bulb, I am constantly learning. This allows me to get a better understanding of the technology I am working with and provides me with valuable knowledge that I can then share with others. I believe information learned should be passed on to our new Sailors. Because in the end, our new Sailors are the future and this new technology is what they're going to be working on. Eventually I am going to leave so passing on what I know is important and something I take pride in.

I also work with a lot of great people. And no matter what, we always stand together and get the job done. In the end it's our teamwork that keeps me motivated. In my shop, we have five to six people at any one time. This small group makes us even closer. It's really good to work with people you know and trust because with equipment like this, you're putting your life into their hands. If I know I can trust them, I know I can do my job better.

Q: WHAT IS AN ENERGY WARRIOR?

An Energy Warrior is someone who is building a brighter future. Being energy efficient and going "green" is a big transition and a big step for our Navy, our mission, and our fleet as a whole. It will not only save us a lot of money but it will also help us become a more reliable force.

Biofouling Remediation Equals Higher Speed, Lower Drag

Advancements in Biofouling Control R&D Offer Increased Capability to Navy Vessels

ENGINEERS AND SCIENTISTS at the Naval Surface Warfare Center, Carderock Division (NSWCCD) have been studying commercial advancements that have the potential to improve hull and propeller coatings thereby reducing the formation of biofouling and lengthening the intervals between cleanings.

combatant and Military Sealift Command (MSC) vessels today.

The effects of biofouling are straightforward—biofouling accumulation increases the surface roughness of a hull and its associated frictional drag. Increased frictional resistance results in increased fuel consumption and decreased speed and range. To increase

Biofouling accumulation has been an issue for the Navy since the days of the sail, and the approach for mitigating biofouling—scraping the hull and propeller by hand or with grinding tools—has not been substantially improved in decades.

Improving hull and propeller coatings could reduce the formation of

Biofouling may actually represent the single largest factor undermining fuel efficiency in surface combatant and Military Sealift Command vessels today.

Biofouling, also known as barnacles and slime, may not be the trendiest, high-tech topic of conversation in the world of operational energy. Most would rather discuss a new weapon system or innovative green technology that allows Sailors and Marines to increase operational tempo or achieve more efficient fuel consumption. What most people don't realize is that biofouling may actually represent the single largest factor undermining fuel efficiency in surface

operational capability and efficiency, most would rather discuss swapping one design for another—maybe a new hull form, a new propeller design, or a new technology that could result in more fuel-efficient operations, often ignoring the impact of something as uninteresting as biofouling. However, mitigating the effects of biofouling could result in significant increases in fuel efficiency and enhanced operational capability in terms of increased range and top speed.

biofouling and lengthen the intervals between cleanings. An NSWCCD team has been studying advancements in commercial coatings and their applicability to Navy vessels. The NSWCCD is also collaborating with Naval Sea Systems Command (NAVSEA) Energy, MSC Operational Logistics (OPLOG) Energy, and other Navy research offices to better understand biofouling's direct effects on fuel efficiency and propulsion. Through better measuring of the



Mature barnacles (*Megabalanus tintinnabulum*) on Navy platform.

costs of biofouling, remediation efforts can be monitored and marked as true improvements. In this way, biofouling research and development (R&D) plays a central role in operational energy advancements.

The Challenges of Biofouling

Biofouling describes the accumulation of microorganisms, plants, and animals on wet surfaces. Types of biofouling are generally divided into two categories:

1. **Soft biofouling**

The category of soft biofouling includes biofilm slime, algae and seaweed.

2. **Hard biofouling**

Hard biofouling includes barnacles, tubeworms and mollusks.

The Navy uses a Fouling Rating (FR) score of 0 to 100 combined with a percent area affected when describing the biofouling observed during underwater hull inspections. For example, FR-30 denotes heavy slime while a rating of FR-70 denotes medium hard fouling.

The effects of biofouling accumulation and increased drag are well documented. A growing body of literature is expanding the Navy's understanding of the relationship between measured 'penalties' associated with biofouling accumulation. The NSWCCD team estimates that approximately 14 percent of the propulsive fuel bill for the destroyer (DDG) -class fleet is wasted overcoming the

effects of biofouling. This amounts to 410,000 barrels and \$68 million per year. In 2011, NSWCCD personnel estimated that biofouling cost the Navy \$180 million to \$260 million per year. Modest improvements in the condition of the hull could yield substantial reductions in fuel consumption and cost. A 2010 article in *Biofouling* magazine concluded that the savings achieved from decreasing fouling from FR-30 to FR-20 in the DDG-51 class of ships would offset the costs of a biofouling control R&D program and all associated materials within a year. (Read the entire article at www.dtic.mil/dtic/tr/fulltext/u2/a575004.pdf.)

One of many technical hurdles associated with quantifying the impact of biofouling control improvement on fleet fuel efficiency remains the large variation in ship type and operational conditions across the Fleet. It is also challenging to account for the type and coverage of fouling on hulls and propellers because measuring biofouling accumulation in and of itself is not a scheduling priority for the Navy. Measuring and quantifying biofouling impact is an important focus of ongoing projects.

The full costs associated with biofouling are not tied to fuel penalties alone. The increased frictional drag on a vessel also increases the shaft power required to attain a particular speed and can reduce vessel top speed. According to the Office of Naval Research, biofouling can reduce a vessel's speed by up to 10 percent.

One point remains clear: improved biofouling control will directly reduce drag and the associated increase in fuel

Without a rigorous biofouling control R&D program, the Navy may continue to struggle to identify effective solutions and justify their transition with sound cost benefit analyses.

consumed for propulsion. At the same time, mitigating biofouling returns capability to the vessel, an issue far broader than fuel consumption calculations alone.

A Unique Set of Challenges in the Navy

The battle against biofouling is arguably more challenging for military vessels than for most commercial vessels for a number of reasons. The most important factor is probably tied to operational tempo which is comprised of two main components—the frequency with which ships get underway and the speed-time profile of vessels when they

are underway (the percent of time spent at each speed). The average Navy ship is underway less frequently than most commercial ships, and steams at a lower and a wider array of speeds. Not only that, the operational profile of military vessels varies widely across ship classes, making them difficult to characterize. To make matters even more challenging, coating companies typically design biofouling control coating systems for the largest market sector (trade ships). Additionally, mission-essential factors can interfere with researchers' ability to demonstrate new solutions. These and an even wider array of interconnected variables present unique challenges to the Navy

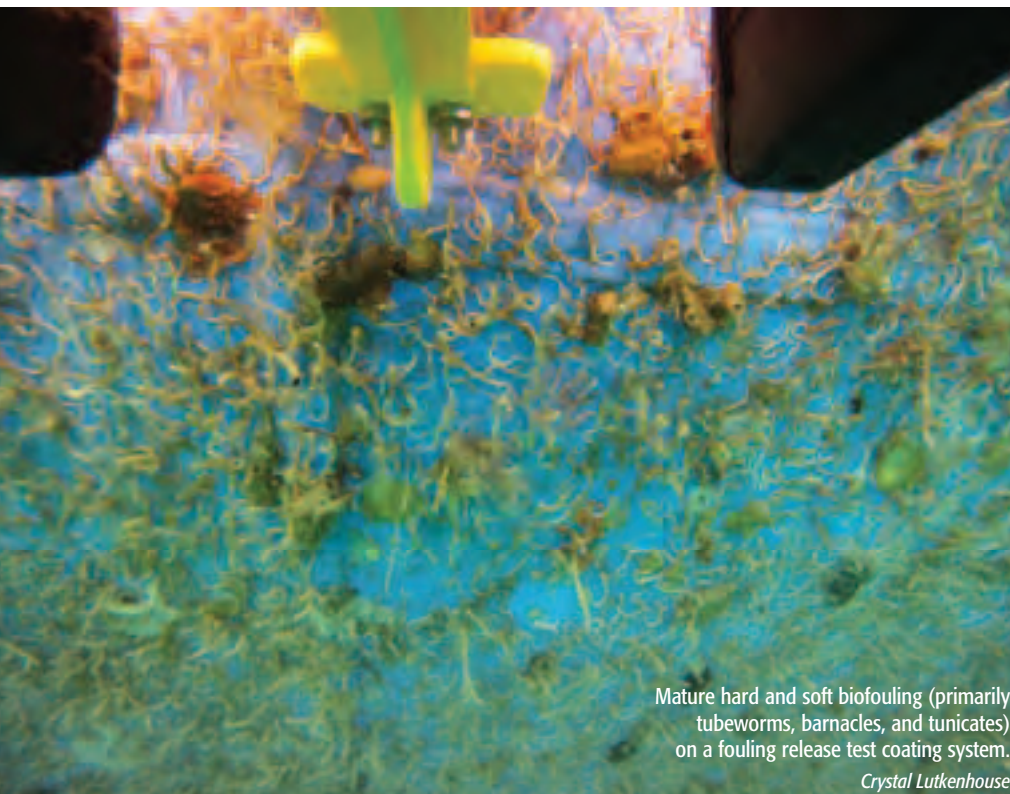
when working to bring advanced biofouling control solutions to the Fleet.

While the combination of advanced coatings and maintenance practices seems like a straightforward solution to the problem, the efficacy of these solutions is linked to a set of interdependent variables that must be taken into consideration in the overall analysis. NSWCCD has recently described this group of factors as the “4Ms”—Materials, Maintenance, Monitoring, and Movement. For example, coatings fall under the Materials “M.” They should be applied after considering other elements of the vessel’s activities:

- When and how often its hull and propeller are cleaned (Maintenance)
- The quality and quantity of data associated with inspections and fuel efficiency measurements (Monitoring)
- Its operating tempo and speed-time profile (Movement).

Demonstrating and quantifying the benefits associated with advanced coatings are optimized only when all 4Ms are taken into consideration. (For more insights, see our sidebar “More About The 4M’s.”)

Recent demonstration projects involving new fouling release coatings highlighted weaknesses in the way the Navy currently screens, tests, and quantifies the benefits of new coatings. It was determined that without a rigorous biofouling control R&D



Mature hard and soft biofouling (primarily tubeworms, barnacles, and tunicates) on a fouling release test coating system.

Crystal Lutkenhouse

Early reports from paint manufacturers and commercial vessels indicate a 10 percent improvement in fuel efficiency for tankers and 22 percent for bulk cargo vessels with the use of fouling release coatings.

program, the Navy may continue to struggle to identify effective solutions and justify their transition with sound cost benefit analyses.

Working in collaboration with NAVSEA Energy, MSC OPLOG Energy, the Chief of Naval Operations Energy and Environmental Readiness Division (OPNAV N45) and others, the NSWCCD has developed the Navy Biofouling Control R&D Program Plan. This R&D plan seeks to overcome the hurdles that currently get in the way of determining the best combination of solutions to the biofouling problem.

Not a One-Size-Fits-All Solution

The Navy fleet has relied on copper-containing, oxide-based coating technology in combination with in-water cleaning for more than two decades. Because these formulas leach biocides into the surrounding waters, the Navy began to evaluate a new class of biocide-free materials called fouling release coatings in the 1990s. These coatings are based on the concept of reducing the ability of biofilm and barnacles to adhere to the hull (or propeller) through smooth surfaces and hydrodynamic forces. With a

fouling release coating, the biofouling sloughs off when the ship moves.

Fouling release coatings represent at best five percent of the current commercial coatings market, but early reports from paint manufacturers and commercial vessels indicate a 10 percent improvement in fuel efficiency for tankers and 22 percent for bulk cargo vessels with their use.

Conceptually, these paint systems have great potential to provide a biofouling control solution for ship hulls and propellers, and they come with lower environmental impact than legacy biocide-based coatings. In 2008, NAVSEA Energy funded a full-scale demonstration of a commercial fouling release coating on ship hulls and propellers. The International Intersleek® 970 coating system was applied to the propeller of USS Gunston Hall (LSD 44) and to the hulls of USS Cole (DDG 67) and USS Port Royal (CG 73). After four years of monitoring it was determined that, as a hull coating system, this product did not perform as expected and the coating was not yet suitable for the hulls of many Navy vessels. This was largely due to the mismatch between the high volume of movement and speed required to slough off the biofouling and the current operating tempo and speeds of Navy vessels. Most ship classes do not regularly operate often or quickly enough to maximize the benefits of International Intersleek® 970.

While the current generation of fouling release coatings may not have

The 4Ms Affecting Biofouling

A COMPLEX COMBINATION of factors known as “the 4 M’s” affect the impact biofouling is likely to have on a ship’s performance.

1. Materials

There are three main categories of coatings:

- Antifouling: Contains biocides to inhibit bacterial growth
- Fouling Release: Prohibits biological material from affixing tightly and may be sloughed off when ship is underway
- Durable: Withstands frequent cleaning (traditional hard coatings)

2. Maintenance

Tools and techniques used and maintenance frequency all affect coating and biofouling. Maintenance procedures must be compatible with coating material.

3. Monitoring

Hull and propeller fouling condition coupled with underway performance are critical for establishing a baseline, engineering a test plan, and making any conclusions or recommendations regarding coatings.

4. Movement

Operating tempo, speed-time profile, and operating area all affect ship performance and biofouling potential.



Propellers on USS Gunston Hall (LSD 44) after treatment with Intersleek 970 fouling release coating.

David Zuskin

proven to be the panacea that they promised to be for the Navy, they did show promise in specific applications. For example, the fouling release coating performed better on LSD 41-class propellers than it did on hulls. No blade face cleanings were required through at least five years of performance. Early potential also exists on MSC propellers and other vessels with high operating tempos.

In the future, fouling release hull coatings that perform at least as well as if not better than Intersleek 970 may provide improved performance over legacy copper-containing coatings, especially if important formulation changes are made and/or if used on ships with much higher operational tempos. As a propeller coating, Intersleek 970 is being transitioned to the LSD 41-49 class vessels, and the NSWCCD biofouling team is evaluating the suitability of this and other more advanced coating technologies for other ship classes including a subset of MSC vessels.

The Plan: Near- & Long-term

Near-term transition of improved biofouling mitigation strategies is the primary goal of the Navy Biofouling Control R&D Program Plan. This includes identification of mature, commercially available coatings and development of an effective maintenance regimen.

Because the current generation of fouling release coatings appears to be a poor match for the majority of Navy vessel hulls, the NSWCCD biofouling team plans to turn its attention to emerging antifouling coatings in the near term.

Self-polishing copolymer (SPC) paint systems have been used globally for more than a decade now—and are currently being transitioned to the Royal Australian Navy—but have only recently become available for use in the U.S. These formulations contain biocides which aid in preventing biofouling formation. In fiscal year (FY) 2016, the team will perform an American Society for Testing and Materials test to determine the copper release rate of commercially available SPC formulations. Those products that release more copper than legacy copper ablative coatings used by the Navy will be disqualified. Those releasing the same or less copper will be included in planned panel and ship testing in early FY17. The aim is to identify not only better-performing coatings but also more environmentally friendly systems.

The NSWCCD biofouling team will leverage and build on lessons learned from their recent experience with fouling release coatings while applying the principles of the 4Ms.

In addition to testing emerging hull and propeller coatings, NSWCCD's R&D plan includes the following:



Shipyard workers in San Diego use high-pressure water to clean the hull of the amphibious assault ship USS Bonhomme Richard (LHD 6).

CMC Specialist Joe Kane

- Developing tools and models to calculate fuel savings associated with hull coating performance.
- Improving screening test methods.
- Characterizing ship operations.
- Tracking coating system service life, performance, and maintenance history.

Among other collaborative efforts, the biofouling team plans to continue to engage with relevant members of the Navy community by attending several conferences such as the Fleet Maintenance and Modernization Symposium, the International Congress on Marine Corrosion and Fouling, and the Hull Performance & Insight Conference (HullPIC).

Summary

The challenges associated with defeating biofouling have existed since even before the birth of the Navy. NSWCCD and its partners and sponsors recognize the current opportunity to build on the momentum from recent projects to modernize the Navy's solution sets to biofouling remediation.

The solution to the biofouling problem in the military fleet is unlikely to be as simple as changing over to the newest hull coating technology, at least not without asking the right questions. NSWCCD's R&D plan attempts to identify the right set of interdependent variables to account for as they determine the suitability of biofouling control solutions for the Navy fleet. Reducing the Fleet's baseline biofouling condition will reduce cost (fuel and maintenance) and enhance capability for Navy warfighters. When the NSWCCD-led efforts are successful, more ships can go to sea for the same fuel budget, and operational efficacy (top speed, range, time between re-fueling) will be enhanced. From the operational energy viewpoint, the Navy Biofouling Control Program will pay deep dividends in the long run. [🔗](#)

Elizabeth Haslbeck
Naval Surface Warfare Center, Carderock Division
301-227-4784
DSN: 287-4784
elizabeth.haslbeck@navy.mil

Elizabeth Oakes
Navy Energy Coordination Office
703-695-5090
DSN: 695-5090
elizabeth.oakes.ctr@navy.mil

Representing the Department of Defense in Environmental Matters

Assistant Attorney General John Cruden Shares His Perspectives With *Currents* Readers



IN JANUARY 2015, I returned to the U.S. Department of Justice as the Assistant Attorney General for the Environment and Natural Resources Division (ENRD) after spending 2011 to the end of 2014 as President of the Environmental Law

- Protect the public fisc (i.e., treasury) and defend the interests of the United States.
- Enforce the nation's bedrock environmental laws to protect air, land, and water for all Americans.

sented the Defense Department have matured and expanded over the years, much as the field of environmental law has itself developed and changed over time.

Since its creation over a century ago, the Environment and Natural Resources Division has represented the interests of the Department of Defense in a variety of affirmative and defensive matters.

Institute. I am, however, well aware of the broad array of important legal issues that arise in the course of the Department of Defense's (DoD) work. I graduated from West Point and served in multiple legal positions at the DoD before joining the Department of Justice, and served as the chief of the Environmental Enforcement Section and then the Deputy Assistant Attorney General over two decades.

As the Assistant Attorney General, two of my five goals for ENRD are to:

These priorities are closely linked with ENRD's representation of the DoD, past and present. To fully understand the interconnection between these two goals in relation to ENRD's representation of the DoD, one must understand the history of ENRD at the Justice Department and its organizational structure.

Since its creation over a century ago, ENRD has represented the interests of the DoD in a variety of affirmative and defensive matters. The legal issues as to which ENRD has repre-

ENRD was first called the Public Lands Division at its inception on November 16, 1909. It was originally created to handle all suits and proceedings concerning the enforcement of public land law on behalf of the United States, including litigation related to Indian rights. As the nation's laws developed, the responsibilities of the Public Lands Division expanded. It was renamed as the Lands Division in 1933, and then again as the Lands and Natural Resources Division in 1965 to more accurately reflect its work that

included protecting public interests in natural resources in addition to administering public land law. The mission and workload changed most significantly with the passage of a suite of environmental and natural resource laws in the 1970s and 1980s. These included the National Environmental Policy Act, Clean Air Act, Clean Water Act, and Endangered Species Act among others along with the creation of the U.S. Environmental Protection Agency (EPA) and other agencies. The Division was renamed in 1990 as ENRD to reflect the growing environmental case workload. The responsibilities of ENRD have continued to evolve, including the recent addition of the animal welfare and worker safety laws to its responsibilities.

Structure of the Environment and Natural Resources Division

ENRD is composed of the Assistant Attorney General, a presidentially appointed and Senate confirmed position, as well as four deputy assistant attorneys general and ten sections. With the exception of the section that is the Executive Office, the nine litigating sections are structured based upon areas of substantive law. The litigating sections include:

1. Environmental Defense
2. Natural Resources
3. Land Acquisition
4. Appellate
5. Wildlife and Marine Resources
6. Environmental Enforcement
7. Law and Policy
8. Environmental Crimes
9. Indian Resources



John C. Cruden

ENRD employs over 600 staff, including more than 400 attorneys, who are primarily located in Washington, DC. Approximately 70 staff are located in field offices in Sacramento and San Francisco, California, and Denver, Colorado, with Denver being the largest field office.

In any given year, ENRD's caseload is roughly equally divided between affirmative and defensive litigation. The top five agencies ENRD primarily represents, in order of case volume, are the EPA, Department of Interior, DoD, Department of Agriculture, and Department of Commerce (National Oceanic and Atmospheric Administration). In any given year, the Defense Department consistently ranks third in volume of cases among the federal agencies ENRD represents.

The ENRD section with which the Defense Department has the most interaction is the Environmental Defense Section (EDS). As the name implies, EDS represents the United States in all defensive litigation for

alleged violations of the various pollution control laws. Despite its name, EDS's responsibilities also include some affirmative litigation. EDS represents the United States in all affirmative civil judicial litigation enforcing Section 404 of the Clean Water Act (a/k/a wetlands or waters of the United States matters) and certain aspects of Sections 10 and 13 of the Rivers and Harbors Act. The primary agencies EDS represents in bringing these cases are the U.S. Army Corps of Engineers and the EPA.

The Natural Resources Section (NRS) represents the United States in defensive litigation arising under more than 80 statutes, treaties, and the U.S. Constitution related to federal lands, resources and ecosystem management issues. NRS also represents the United States in Fifth Amendment takings matters involving federal activities affecting private property. An example of the type of Fifth Amendment takings

In any given year, the Defense Department consistently ranks third in volume of cases among the federal agencies the Environment and Natural Resources Division represents.

cases in which NRS has represented the Department of Navy involve over-flight cases, such as the litigation in *Testwuide et al. v. United States* (Fed. Cl.). Through the successful and cooperative working relationship between NRS and the Department of Navy, ENRD has been able to negotiate several settlements in these cases.

The acquisition of land for public lands and government operations, including protecting the homeland, has been a continuous part of ENRD's work since its creation. The Land Acquisition Section (LAS) is one of our oldest practice areas and is responsible for eminent domain and condemnation matters for the United States. LAS's work includes affirmative condemnation cases, appraisal reviews and title matters. LAS is currently working with the Navy in San Diego in a case which will be discussed later.

The Appellate Section handles the civil and criminal appeals work of ENRD. The Appellate Section handles appeals from district court cases under ENRD's purview, encompassing more than 200 statutes and petitions for review for the Department of Energy, Federal Energy Regulatory Commission, and Federal Aviation Administration. In a typical year, the Appellate Section handles approximately 250 cases, including several Supreme Court merits cases. More than half of the cases are typically in the Ninth and Tenth Circuits due to the vast amount of federal land in the western United States.

The Wildlife and Marine Resources Section (WMRS) is responsible for civil enforcement of the federal wildlife and marine species conservation laws and the animal welfare laws as well as defense against suits brought under the same laws. These laws include the Endangered Species Act, Migratory Bird Treaty Act, Marine Mammal Protection Act, and Animal Welfare Act among others. WMRS and NRS were responsible for defending the Navy sonar activities in a series of high profiles cases.

The Environmental Enforcement Section (EES) litigates all affirmative cases under the federal environmental pollution laws, except those enforced by EDS discussed earlier. The Defense Department interacts with EES when EDS is representing the Defense Department for alleged violations of the pollution control laws. This most often occurs in matters involving the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) matters.

The remaining ENRD sections that work less frequently with the Defense Department include the Law and Policy Section, Executive Office, Environmental Crimes Section, and the Indian Resources Section. The Law and Policy Section handles a broad variety of environmental legal and policy matters, including reviewing pending regulations and legislation, ENRD's international work, and the amicus practice in federal district

courts and state courts. The Executive Office provides ENRD administrative support in addition to litigation support for the nine litigating sections and client agencies (e.g., discovery). The Environmental Crimes Section prosecutes individuals and corporations who criminally violate the laws under ENRD's purview and associated general crimes under Title 18 of the United States Code (e.g., false statements and conspiracy). The Indian Resources Section represents the United States in litigation to protect tribal lands, resources, and jurisdiction and treaty rights. This includes defense of federal statutes, regulations, programs, and actions benefiting Indian tribes and their members.

Appellate Practice

As Deputy Solicitor General Michael Dreeben explains, "While the United States has a special obligation to serve the broader interests of justice in every court, appellate lawyering offers an especially pure form of this duty. In appellate courts, the government is constantly balancing its interest in prevailing in an individual case with its broader interest in establishing sound rules of law that serve the national interest." (United States Attorneys' Bulletin, January 2013, vol. 61, no. 1, p. 5.)

ENRD, like each litigating division of the Justice Department, has an appellate section which in turn handles that division's cases in federal courts of appeal, state courts of appeal, and in

state Supreme Courts. Much of the ENRD appellate work in state appellate courts relates to the allocation of water resources, which is generally a state responsibility. While the trial sections may sometimes be required to defend less than ideal agency records in district courts, the appellate process gives the United States the authority to decline to pursue an adverse decision in the court of appeals where the record presents considerable litigation risks or where broader institutional interests counsel against an appeal.

When the United States loses a case or receives an adverse decision in a lower court, an appeal may only be authorized by the Solicitor General. Under federal regulations and Justice Department policy, the Solicitor General is responsible for deciding whether any appeal is filed by the government in the appellate courts including petitions for rehearing en banc (i.e., before the full court of

Section obtains recommendations from the client agency and the trial section, including where applicable the local U.S. Attorney's Office. Other agencies with an interest in the litigation may also provide recommendations to the Appellate Section. The Appellate Section submits a preliminary recommendation to the Assistant Attorney General, and then submits the final recommendation including the trial and agency recommendations to the Solicitor General who makes the final decision.

ENRD works very closely with the Office of the Solicitor General on decisions about appeals and on briefs in ENRD cases being filed before the U.S. Supreme Court. ENRD typically coordinates client agency reviews of the Office of the Solicitor General drafts. The client agency and ENRD may participate in the moot courts in advance of oral arguments before the U.S. Supreme Court.

Given that the Justice Department, an executive agency, represents all other executive agencies in legal matters, this often raises the question of whether there is a legal conflict of interest in these multiple representations. In the private sector, it is a general and fundamental rule of professional conduct that an attorney or law firm cannot represent opposing parties in the same cause of action. However, when two agencies' interests in a case differ, the Justice Department does not have a conflict of interest. The Justice Department and the relevant agencies all represent the United States. Any conflict among different agencies are to be resolved internally within the Justice Department, by the Attorney General if necessary, so that the government presents a unified position in court on behalf of the executive branch. The U.S. Supreme Court in *Nevada v. United States*, 463 U.S. 110 (1983) and several other federal appellate

Given that the Justice Department, an executive agency, represents all other executive agencies in legal matters, this often raises the question of whether there is a legal conflict of interest in these multiple representations.

appeals judges), amicus filings in appellate courts, petitions for certiorari (i.e., request for a higher court to review a lower court decision), and petitions for extraordinary writs. See 28 C.F.R. § 0.20(b)(c) and Department of Justice, United States Attorneys' Manual §9-2.100. These decisions are made in consultation with the agency.

In deciding whether to recommend appeal of an adverse decision to the Solicitor General, ENRD's Appellate

Client Agency Concept

The Justice Department represents the United States (i.e., the Executive Branch) in court. The fundamental proposition that the United States is the client and not just the agency is sometimes referred to as the unitary executive principle. That concept has its foundations in Article II of the U.S. Constitution. Under Section 1 of Article II, the power of the Executive Branch of government is vested in the President of the United States.

and district court opinions have all generally held that where the Justice Department is charged by law to represent multiple interests, there is no conflict of interest of the type that would arise if private counsel attempted multiple representations of different entities.

ENRD is often called upon to resolve disputes between agencies regarding litigation positions. To determine the position of the United States on a

particular issue in trial practice, and especially in appellate litigation, all interested components within the government have the opportunity to be heard through written memoranda and often through meetings with ENRD leadership.

Although the process of arriving at a single United States legal position can sometimes take some time, the result is that the government has a consistent understanding of the application of the law, whatever the interests of the government may be in a particular matter. That approach is highly beneficial to the rule of law.

Case Examples

Most, if not all, of the matters in which ENRD represents the Department of Navy involve the goals I have established for the Division:

1. Protecting the public fisc and defending the interests of the United States
2. Enforcing the nation's bedrock environmental laws to protect air, land, and water for all Americans.

The cases described below are examples of successful cases on behalf of the Department of Navy that also demonstrate how ENRD is meeting these goals.

U.S. v. 32.42 Acres of Land, 683 F.3d 1030 (9th Cir. 2012), is a successful condemnation case that protected the public fisc and defended our nation's national security interests by obtaining land for the Anti-Submarine Warfare Training Center in San Diego, California. In 2005, a condemnation suit was filed to acquire the outstanding interests in filled tidelands that were under a 50-year lease agreement to the United States for the Navy's training center. Suit was filed against the San Diego Unified Port District which owned the underlying fee estate that was subject to a public trust interest of the State of California. The San Diego Port District initially claimed its interest, right to return of the property on August 8, 2049, was worth in excess of \$50 million dollars. A number of pre-trial rulings permitted the taking and recognized the legal parameters as to the property's development potential which resulted in a decrease of the San Diego Port District's valuation. After a trial, a federal jury set the just compensation at \$2.91 million dollars. The San Diego Port District appealed, and the Ninth Circuit affirmed the district court by holding that the United States could extinguish the state's public trust rights when federal eminent domain is exercised.

ENRD has been working with the Navy to acquire lands necessary for the Broadway Complex redevelopment project that was authorized by Congress in 1986. Currently, ENRD is representing the Navy in *United States v. 1.647 Acres (0.826 +/- Acres - E Street Corridor and 0.821 +/- F Street Corridor) of Land, More or Less, Located in San Diego County, State of California, et al.*, (S.D. Cal.), to condemn a fee simple interest in segments of two streets in San Diego for the redevelopment project. This taking has been challenged by the San Diego Port District and the State. These streets have been the subject of two prior condemnation cases in the 1990s by the United States involving the San Diego Port District and the State. The pending challenges to the United States' right to take the property include there is no statutory authority for the taking based upon the property value; the property is being taken for private commercial development instead of a public purpose; and waiver and preclusion issues apply from prior condemnation litigation.

In re *Water Use Permit Application*, 9 P.3d 409 (HI 2000), is an example of a successful water allocation case litigated in a state Supreme Court. In this multi-party litigation, ENRD represented the Department of Navy's interests to ensure that water allocations were available to recharge the Pearl Harbor aquifer.

In *Natural Resources Defense Council v. Blank* (N.D. Cal.), we successfully defended the Department of Navy's use of the antisubmarine surveillance system known as Surveillance



The Military Sealift Command ocean surveillance ship USNS Impeccable (T-AGOS-23) is one of five ocean surveillance ships that are part of the 25 ships in the Military Sealift Command Special Mission Ships Program. Impeccable directly supports the Navy by using both passive and active low frequency sonar arrays to detect and track undersea threats.

Towed Array Sensor System Low Frequency Active sonar (SURTASS LFA). The plaintiffs alleged that the National Marine Fisheries Service and the Department of Navy violated the National Environmental Policy Act, Endangered Species Act, and Marine Mammal Protection Act by authorizing the deployment of SURTASS LFA, especially during concentrated training exercises, would harm thousands of marine mammals, including endangered and threatened species. At the conclusion of this litigation, ENRD was able to prevent the entry of any injunction and successful in disposing the majority of the case. The one minor area where we were unsuccessful was easily remedied without interruption to the Navy's training exercises.

Winter v. Natural Resources Defense Council, 555 U.S. 7 (2008), is the case successfully litigated before the U.S. Supreme Court that preserved the Department of Navy's ability to use mid-frequency active sonar during drills given the possibility of harm to marine mammals. The issue before the Court was whether the Navy's decision to conduct training exercises off the coast of southern California complied with the National Environmental Policy Act, the Coastal Zone Management Act, and the Endangered Species Act. A series of judicial decisions were issued by the district court and Ninth Circuit that culminated in a district court issuing a preliminary injunction to the Department of Navy that imposed restrictions on the use of sonar in Navy exercises off the coast of southern California.

The Council on Environmental Quality authorized the Navy to implement an alternative arrangement to National Environmental Policy Act compliance

and allowed it to continue its exercises under voluntary mitigation procedures that were previously adopted. The Supreme Court vacated the preliminary injunction, holding that the lower courts had misapplied the preliminary injunction standard and abused their discretion by imposing restrictions on the training exercises. The Court found that by entering a preliminary injunction based on plaintiffs' showing of the mere "possibility" of irreparable harm, the lower courts set the bar too low for such an extraordinary remedy. The Court further held that the balance of the equities and the public interest strongly favored allowing the Navy exercises to proceed without the restrictions imposed by the lower courts, as the interests of the Navy in conducting realistic training exercises outweighed the plaintiffs' interests.

Subsequently, the case was resolved by an out of court settlement. As part of the settlement, the Navy affirmed its previously stated commitment to completing National Environmental Policy Act compliance documents and Endangered Species Act and Marine Mammal Protection Act compliance documents if applicable for various training ranges consistent with its comprehensive strategy to assess the effects of mid-frequency sonar on the marine environment.

Conclusion

Protecting governmental interests, such as national defense and the national

For More Information

MORE INFORMATION ABOUT ENRD, including case resolutions, can be found at www.justice.gov/enrd.



treasury, while simultaneously protecting the environment and natural resources are clear goals for the Justice and Defense Departments who have a long rich history of addressing these issues. ENRD has a long history of working with all components of the Navy and consider it a great honor to represent the Navy in court—working to protect national security concerns and fulfill the missions of the Navy while simultaneously advancing the environment. Our experience has been that Navy officials and their attorneys are superb professionals, extremely committed, very knowledgeable, and absolutely fun to work with. ⚓

John C. Cruden
Assistant Attorney General for the Environment
and Natural Resources Division
U.S. Department of Justice

Laurie Dubriel
U.S. Department of Justice
Environment and Natural Resources Division
202-616-7349
laurie.dubriel@usdoj.gov



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Marine Corps Sponsors Study to Better Understand Energy Use

Naval Postgraduate School Recommends Changes in Practices to Promote Energy Efficiency

RECENT RESEARCH INITIATED by the Marine Corps Expeditionary Energy Office (E2O) has shed some light on how fuel and energy are used in the field. A series of studies conducted by a team at the Naval Postgraduate School (NPS) have contributed to a number of initiatives including procedural changes and a war games exercise.

The E2O was formed in 2009 to address energy-related vulnerabilities within the Marine Corps. The then-director of E2O, Colonel James C. Caley, asked NPS researchers to create a framework with which to assess the human factors impacting the adoption of new energy policies and technologies. (Note: For more information about E2O, see the summer 2014 *Currents* interview with Col. Caley at <http://greenfleet.dodlive.mil/currents-magazine/currents-magazine-2014/currents-summer-2014>.)

According to Col. Caley, the NPS team's research has changed his thinking about energy problems in the Marine

Corps, shifting his thinking to a greater emphasis on behavior. "The Marine Corps has thousands of pieces of equipment. Do you know what the most common piece of equipment is? The Marine," he said. In trying to further understand the impact of a Marine's energy use, Caley recently set up a seminar war game using computer tools and models to project how today's energy policies and usage patterns could backfire down the road.



Colonel James C. Caley



The end product of this study was a behavioral framework that explains how Marines' personal knowledge, attitudes, values, and motivations vary by each scenario.

Operational Reach 2015

In June 2015, 75 individuals from the Marines, Air Force, Army, Navy, the Office of the Secretary of Defense, and Allied Nations met in Quantico, Virginia for Operational Reach 2015, a war game about energy and fuel set in 2030. This marked the first time that energy was included in an operational planning exercise. The exercise identified issues concerning new naval concepts and weapons systems such as fuel storage, load measurement, vehicle travel, equipment distribution, follow-on operations and energy implications.

"Units cover more battle space than they used to, they have more fire power and they're better protected," says Caley. "But that increase in capability has come with a cost on the energy side of the house that we haven't entirely kept up with."

The results of Operational Reach 2015 uncovered risks and vulnerabilities for the Marine Corps, especially when Marines need to operate deep in country untethered from energy resupply, and highlighted the system-wide need for change.

Old Habits Die Hard

Col. Caley remembers when he first joined the Marine Corps, "We had trucks called 813's. If you didn't start your vehicle 45 minutes before operations, or jump start the ones that wouldn't start, you were going to feel the pain of that decision. Today,

M2VR trucks start in two to three seconds, but we still start our engines 20-30 minutes early. And no one knows why."

"We are prone to wasting our fuel— idling trucks, running generators at 35 percent of their load," Caley continued. "So I turned to the NPS researchers because I wanted a multi-disciplinary approach to energy consumption, to look from the perspective of psychology, sociology, and business development. Now we are getting a fresh set of eyes on Marine Corps behaviors and our standard operating procedures."

The Study

The Study of Human Behavior and Operational Energy looked at the ways in which situational and personal factors routinely impact how energy is used. The report is the most recent output from a stream of studies conducted by a team of NPS researchers including Kathryn Aten, Anita Salem and Ann Gallenson. This study is based on interviews and observations of over 60 Marines in three training exercises and a deployed expeditionary command environment. The end product of this study was a behavioral framework

The Marines & the Naval Postgraduate School

PROFESSOR ALEJANDRO (ANDY) Hernandez, Col. (retired), program manager at NPS for E2O, says that Col. Caley has partnered with NPS for the past three years to get a new and comprehensive perspective on the E2O mission. According to Col. Hernandez, NPS supports E2O in four areas:

1. New innovations in processes and systems
2. Untethering from major resupply bases
3. Challenges in delivery and storage capacity
4. Organizational adaptation which includes decision-making, improved command and control, and education and training.

NPS uses teams that combine faculty expertise and student operational experience to deliver research and theses that address behavioral, organizational, and technical challenges in effective energy use. Current behavioral and organizational research includes the modeling and simulation of energy use in the field, industry recommendations on the use of vehicle telematics, and Commander-designed fuel information systems. Technical solutions include new technologies such as solar drones and robots to carry 100-pound backpacks for Marines.



Marine Corps Captain Brandon Newell shows Secretary of the Navy Ray Mabus how Sailors and Marines are using the GREENS equipment at Boldak Expeditionary Energy Patrol Base in Helmand Province, Afghanistan.

CMC Sam Shavers

that explains how Marines' personal knowledge, attitudes, values, and motivations vary by each scenario. The report had immediate impact and sets out the behavioral basis for continuing research.

The Marines were observed and interviewed during and after integrated training exercises, during Weapons and Tactics Instructor exercises and while embarked on a Landing Helicopter Deck amphibious assault ship with a deployed Marine Expeditionary Unit.

Personal Factors

A key finding of the research was that energy behaviors and key influencers varied by community and activity. In general, researchers found that Marines' willingness to be energy efficient is impacted by the following factors.

NPS is developing a new energy efficiency course that integrates energy concepts into operational planning and wargaming.

Awareness

The researchers concluded that many Marines are not aware of fuel use and its impact on the mission. For example, Humvee drivers idle their engines in order to be ready to move the vehicle quickly when attacking or being attacked. They also idle engines to recharge batteries for artillery and to maintain vital communications with fellow Marines. However, previous to this study, there was no policy or standard regarding how much time should be spent idling a Humvee. When drivers were asked how long they should idle to charge batteries, some Marines said five minutes, while others gave answers ranging up to 30 minutes. Even though the Marine Corps has been looking at energy as a force multiplier, there was very little discussion in the exercise about the human costs of using so much fuel, such as the number of casualties from enemy attacks on fuel convoys. These costs are significant. A report issued by General James Amos in 2010 found that during one three-month period in Afghanistan, one out of every 50 fuel and water convoys resulted in a Marine being wounded in action.

Little Accountability for Fuel Use

The study also revealed gaps in individual awareness of financial impacts. A common attitude seemed to be that fuel is not a top concern—"We always have what we need" and "It's not coming out of our wallets." There was minimal awareness of fuel use and no observed unit accountability for expenditures. Mechanisms for tracking and managing finances were also lacking.

Motivation

As in many large organizations, there is general resistance to change in the Marine Corps. Adding new energy policies is seen as "just one more thing to do." The burden of paperwork and the perceived tendency for the Department of Defense to overreact to problems were cited as causes of resistance. At the same time, the researchers saw indications that Marine Corps values such as professionalism, resilience, resourcefulness, and pride of work could serve as strong motivators.

The researchers concluded that a combination of strategic, operational and tactical practices can effectively reduce energy use in the Marine Corps.

Effectiveness Trumps Efficiency

The prevailing attitude was that nothing should adversely affect operations and training. While some interviewees recognized the efficiency of making fuel last as long as possible, many enlisted Marines had no concept of extending reach through energy efficiency. Safety and well-maintained equipment were of more concern.

Knowledge

Researchers identified a lack of energy planning and management at the senior levels. In one case, a utilities engineer developed a plan which would conserve energy use that was overridden by his superiors. In addition, the ranks of utility engineers (most often responsible for energy planning) are shrinking.

Leadership

Direction and support from top leadership can be an important part of changing the focus to an energy conscious force. Junior ranks are looking to senior leadership to set the example: “Energy? That’s for other people to think about—those above me.” Some senior leadership recognized this important role—“I’m a steward. It’s my job to pay attention to money and efficiency and effectiveness.”

The researchers concluded that a combination of strategic, operational and tactical practices can effectively reduce energy use in the Marine Corps. They created a five-factor model for effecting change.

Five Steps Toward Changing the Culture

1. Improve Specific Procedure

Researchers found that energy requirements are often based on worst case scenarios, and don’t account for the ebb and flow of combat operations. Changes were recommended in areas ranging from idling policies (no more than five minutes) and battery charging procedures to logistical planning for Marine training exercises, optimizing flight paths for pilots, and installing driver fuel meters.



New fact sheets were created describing improved procedures for tanks, motor transport and amphibious assault vehicles.

New fact sheets were created describing improved procedures for tanks, motor transport and amphibious assault vehicles. These were created for Military Occupational Specialty (MOS) schools, and include information about smart driving techniques, preventive maintenance checks, starting and shutting down engines, and the use of personal heaters. MOS fact sheets can be found at www.hqmc.marines.mil/e2o/E2OHome.aspx.

2. Revise Policies

Many of the current structures of the Marine Corps are at odds with reducing energy use. The study cited the length and design of exercises, coordination between the Ground Forces and Logistics, and the availability of utility engineers as factors that affect energy use. Various tactical and operational strategies could be revisited regarding their energy impact. For instance, a tactical strategy might include looking at new ways to transport goods while an operational strategy might revisit the role of the Medical Corps in refrigeration planning.

Other policy recommendations in the study focus on the length, tempo, and time of day of training exercises. One Marine interviewed mentioned a training exercise that was expected to last three days, and turned into thirty days with ten times the amount of fuel burned. This may well have been an appropriate use of time and energy, but the use of energy should have been a formal consideration.



U.S. Marine Corps



U.S. Marine Corps



Sgt. Christopher Q. Stone



U.S. Navy



*Master Sgt.
William Price*



U.S. Marine Corps



MCS2 Christopher Lindahl





A convoy of Amphibious Assault Vehicles assigned to 3rd Amphibious Assault Battalion, line the shores of Oahu, ready to make their way back aboard the amphibious assault ship USS Peleliu (LHA 5) after combat training exercises.

PM2 Prince A. Hughes III

A revision in financial and incentive policies was also recommended. One key policy shift would be to make each unit accountable for their energy use, and to provide incentives for energy-efficient behaviors. For example, the study revealed gaps in individual awareness of financial impacts, in tracking and managing finances, and in unit accountability for expenditures. There was a sense of abundance among many of the

Marines interviewed, and a disconnect between using energy and paying the energy bills. One way to incentivize Marines to be energy-efficient is to reward and recognize units that are more efficient by providing additional educational benefits, more liberty, and/or more pay. Another way is to build on collective values that align with the desired culture change such as resourcefulness, resilience, adaptability, and pride.

OPPOSITE PAGE, CLOCKWISE FROM TOP:

Solar photovoltaic panels demonstrated at the 2013 ExFOB (now E2C) technology demonstration, held 6–10 May 2013 at Marine Corps Air Ground Combat Center Twentynine Palms, CA.

Materials Requirements Analyst Major Sean Sadlier, energy officer for Marine Corps Pentagon Headquarters, demonstrates Ground Renewable Expeditionary Energy (GREENS) apparatus at the Naval Surface Warfare Center, Carderock Division. The GREENS program is sponsored by the Office of Naval Research.

Marines with the Communications Section, Combat Logistics Battalion 24, 24th Marine Expeditionary Unit train on GREENS on the flight deck of USS Gunston Hall. Marines use the system, which generates electricity through solar power, to power command operation centers.

The NPS behavioral study initiated the first-ever guidance regarding idling vehicles such as Humvees. The Ground Renewable Expeditionary Energy Network System.

Lance Cpl. Dakota Hicks connects a radio battery to a Solar Portable Alternative Communication Energy System (SPACES) at Patrol Base Gumbatty in Sangin District. SPACES is a flexible solar panel that can be carried by a Marine and is used for recharging radio batteries. With more room in their packs from fewer batteries, the coalition forces can pack more essentials, like ammunition.

Hybrid power systems.

Sgt. Christopher Q. Stone transmits imagery using a Broadband Global Area Network powered by SPACES from King Faisal Air Base in Jordan to the USS Kearsarge (LHD 3) at sea.

3. Integrate Enhanced Technology

Integrating appropriate and usable technology was also identified as key. A Marine in Afghanistan or Iraq routinely carries between 60 and 100 pounds in gear including batteries and possibly solar cells to recharge communication devices and artillery. Therefore, battery efficiency and solar reliability is key to greater agility. According to one Howitzer operator, “Battery life is short, batteries are heavy, batteries don’t last to spec, they’re not durable, you can’t carry large batteries, and large batteries decrease capability and maneuverability.”

Because of this study, we changed our approach from a focus on equipment to what motivates commanders to make decisions.

—Col. James C. Caley

4. Improve Education.

The study recommends a three-pronged approach to training. Hands-on training should be provided to key personnel. For instance, convoy drivers need to understand the charging requirements of different equipment. Secondly, there is a need for formal training, through MOS schools and continuing education. The third recommendation is to establish methods by which skilled personnel such as utility engineers teach or mentor junior and senior leadership in power planning. The mentoring solution, in particular, might be a cost-effective and efficient way to educate Marines on the benefits of energy efficiency.

5. Use Cultural Levers.

Such qualities as persuasion, influence and leadership are vitally important for changing day-to-day behaviors, particularly in the lower and mid-levels of command. Persuasive communications are most successful (and most influential) when they address the underlying values and motivations of the audience. For example, communicating the personal benefit of carrying lighter weight batteries is likely to persuade soldiers to support solar power.

The Latest Efforts

One direct result of NPS research is the E2O's new Energy Command and Control initiative. Through this program, sensors are being placed in all vehicles, generators, logistics equipment, and airfields so that commanders can tell Marine Corps leadership what makes them more effective in combat. Current research by Aten, Salem and Gallenson is focusing on how the data drawn from these systems can be targeted to the appropriate stakeholders and used to improve situational awareness and operational decision-making.

On the technology side, the Marine Corps hosts an annual event known

as Expeditionary Energy Concepts (E2C), formerly known as Experimental Forward Operating Base (ExFOB), where businesses present innovations in energy technologies and Marines try them out and give feedback. So far, Marines have tested hundreds of technologies and adopted five, including GREENS (a solar-hybrid power systems that can power a battalion combat operations center), SPACES (flexible solar panels to recharge batteries for communications equipment), radiant barriers (shelter liners that resist heat), light emitting diode (LED) lights for tents, and Mobile Electric Hybrid Power Sources (combining batteries, solar, and diesel generators with up to 50 percent fuel savings).

Marines are also implementing changes in driving and vehicle maintenance procedures as outlined on the MOS fact sheets mentioned above. These fact sheets are distributed not only in MOS training, but on the web and in the field. Other education and training efforts have also been impacted by this research. Currently, NPS is developing a new energy efficiency course that integrates energy concepts into operational planning and wargaming and is including behavioral factors in their existing energy seminars for Flag officers, junior and mid-level officers and non-commissioned officers.



U.S. Marines from 1st Platoon, Alpha Company, 1st Battalion, 7th Marine Regiment, patrol from Expeditionary Patrol Base Dulab to a ridge along the outskirts of the city in Dulab, Iraq.
Cpl. Shane S. Keller



Marines from 13th Marine Expeditionary Unit provide security for a CH-46E Sea Knight helicopter during a joint mass casualty training exercise in Grand Bara, Djibouti, near Camp Lemonnier.

PO2 Jesse B. Awalt

The Basics About the Marine Corps Expeditionary Energy Office

THE E2O WAS formed in 2009 to address energy-related vulnerabilities within the Marine Corps Expeditionary Forces. E2O focuses on increasing the operational reach of the forces that operate in harm's way through more efficient energy use. Its mission states that "by 2025...the only liquid fuel needed will be for mobility systems which will be more efficient than systems are today."

The E2O also helps other forces that are training in garrison to get more readiness out of their training dollars. E2O hosts an annual E2C conference that focuses on emerging energy technologies. E2C 2016 is scheduled for 2-6 May 2016. For more about E2O and E2C, see www.hqmc.marines.mil/e2o/E2OHome.aspx.



Looking Ahead

The NPS researchers feel that Integrated Training Exercises (ITX) are an excellent space for exploring new energy-efficient technologies and for instilling the value of energy conservation in recruits. More than one study participant stated that "ITX is where a Marine learns to be a Marine."

The team suggests that ITX is a place where the design of the FOB should be re-examined "to assess the lifecycle impacts of Marine Corps policies and procedures, to analyze the return on investment of energy-hungry technologies and policies that are ill suited for expeditionary conditions."

"The analysis that we're doing is not strictly focused on the expeditionary force," Caley emphasizes. "It's focused on the naval force. We are looking at capabilities that may mitigate some of these increased energy requirements in the expeditionary brigade and across the naval force."

"Because of this study, we changed our approach from a focus on equipment to what motivates commanders to make decisions. We are giving commanders information so they can tell us what makes them more effective in combat. It's a paradigm shift," Caley concluded. [↗](#)

Kathryn Aten
Naval Postgraduate School
831-656-2644
kjaten@nps.edu

Anita Salem
Naval Postgraduate School
831-277-6616
amsalem@nps.edu

Navy Announces 2015 CNO Environmental Award Winners

Annual Awards Recognize Outstanding Environmental Stewardship

VICE ADMIRAL (VADM) Phil Cullom, deputy chief of naval operations for fleet readiness and logistics (N4), announced 29 winners of the fiscal year (FY) 2015 Chief of Naval Operations (CNO) Environmental Awards competition in a naval message on February 22.

The CNO Environmental Awards are an annual recognition program that highlights the accomplishments of nominated ships, installations, and individuals for exceptional achievements in environmental stewardship. The FY 2015 winners, listed alphabetically within each category, are shown below.

Natural Resources Conservation, Small Installation

- Commander Fleet Activities Yokosuka, Japan
- Naval Air Facility Atsugi, Japan
- Pacific Missile Range Facility Barking Sands, Hawaii

Natural Resources Conservation, Individual/Team

- Ian Trefry of Portsmouth Naval Shipyard, Kittery, Maine
- Naval Air Station Oceana and Naval Air Station Hampton Roads NW Annex NR Support Team, Virginia
- Southwest Marine Biology Team of Navy Region Southwest and Naval Facilities Engineering Command (NAVFAC) Southwest, San Diego, California

Environmental Quality, Non-industrial Installation

- Naval Medical Center Portsmouth, Virginia
- Naval Support Activity Mechanicsburg, Pennsylvania
- Navy Region Center Singapore

Environmental Quality, Individual/Team

- Commander Fleet Activities Yokosuka Public Works Department Environmental Management Division Team, Japan
- Naval Station Norfolk Environmental Compliance Team, Norfolk, Virginia
- NAVFAC Northwest Environmental Management System Team, Silverdale, Washington

Sustainability, Industrial Installation

- Fleet Readiness Center Southeast, Jacksonville, Florida
- Fleet Readiness Center Southwest, San Diego, California
- Naval Supply Systems Command Fleet Logistics Center San Diego, California

Environmental Restoration, Installation

- Joint Expeditionary Base Little Creek-Fort Story, Norfolk, Virginia
- Portsmouth Naval Shipyard, Maine

Environmental Restoration, Individual/Team

- Naval Base Ventura County Environmental Restoration Team, San Diego, California
- St. Juliens Creek Annex Environmental Restoration Program Partnering Team, Virginia Beach, Virginia
- Vieques Environmental Restoration Program Team, Puerto Rico

I applaud all of the nominees
for their tireless commitment to
preserving resources and
bettering the environment.

—Vice Admiral Phil Cullom

Cultural Resources Management, Large Installation

- Naval Air Station Fallon, Nevada
- Naval Support Activity Crane, Indiana
- Naval Weapons Station Yorktown, Virginia

Environmental Excellence in Weapon System Acquisition, Large Program

- P-8A Environment, Safety, and Occupational Health Team, Patuxent River, Maryland

Afloat

- Large Deck Combatant: USS Carl Vinson (CVN 70)
- Littoral or Amphibious Warfare: USS Sentry (MCM 3)



MC3 Ashley Hedrick



MC3 Zachary A. Kreitzer



MC2 Martin L. Carey



MC3 Ricardo R. Guzman



MC3 Class Eric Colfer


CLOCKWISE FROM TOP LEFT:
USS Tennessee (SSBN 734), USS Emory S.
Land (AS 39), USS Chafee (DDG 90),
USS Carl Vinson (CVN 70), and
USS Sentry (MCM 3) were all winners
of FY 2015 CNO Environmental
Awards in the "Afloat" category.

- Military Sealift Command:
USS Emory S. Land (AS 39)
- Surface Combatant: USS
Chafee (DDG 90)
- Submarine: USS Tennessee
(SSBN 734)

VADM Cullom commended the awardees in his message announcing the winners.

"I would like to extend my thanks and congratulations to all of the fiscal year 2015 Environmental Award winners. Your efforts not only embody the environmental stewardship ethic, but also aid in fulfilling the Navy's national security mission. I applaud all of the nominees for their tireless commitment to preserving resources and bettering the environment."

Winners of the CNO Environmental Awards will advance to the Secretary of the Navy level of competition to compete with U.S. Marine Corps nominees.

For more information on the CNO Environmental Awards program, visit <http://greenfleet.dodlive.mil/environment/awards>. 

Madeleine Joyce
Chief of Naval Operations Energy and Environmental Readiness Division
703-695-5073
DSN: 225-5073
madeline.joyce.ctr@navy.mil

Naval Academy Professors Team Up to Address Energy Security

Energy Security Demands an Interdisciplinary Approach

IN THE FALL semester of 2015, a group of U.S. Naval Academy professors collaborated to offer a unique approach to teaching energy policy.

The elective brought together professors from Economics, Oceanography, Political Science, and Mechanical Engineering to address the issue of energy security. It was the first course at the Naval Academy to span three academic divisions and four different academic departments.

A total of sixty-eight midshipmen took the class, meeting both as a large group for overview lectures on topics, and in discipline-specific sections for deeper discussions related to the midshipmen's major.

"Our goal was to educate upper-level midshipmen with a high-level view of energy analysis, policy, and security, and in particular, to show how energy issues affect critical missions of the U.S. military and U.S. national security," said mechanical engineering professor and Department Chair Karen Flack, who organized the effort.

The course was divided in four major sections: Overview and Introduction, Fossil Fuels, Nuclear Power, and Renewable Energy. Specific topics included underlying energy science, best estimates of energy supplies and current usage profiles, energy policy trends, current and developing energy technologies, the economics of energy development and usage, and the competing interests and worldviews that drive the energy policy debates.

"Underlying all these topics was the question, 'how do innovation, policy, technology, and economics of energy affect the ability of the U.S. military to successfully and efficiently succeed in its various missions?'" said Flack.

The professors who taught the course knew that teaching a course with this many moving parts was going to be a challenge, but they believed the rewards to the students were well worth the extra effort.

"Energy security is an inherently interdisciplinary issue and demands an interdisciplinary approach," said political science Professor Howard Ernst, who was one of the course's co-instructors. "This was the central vision that we all shared. Our objective was to design a course around this central idea. The challenge was to make sure the course was better than the sum of its parts."

To help achieve this synergy, the professors decided to divide the students into interdisciplinary teams that worked on assignments related to the energy analysis of a specific country, ranging from Pakistan to Korea to France.

"The small teams, what we called core learning groups, forced the students to work across disciplines and gain a holistic understanding of the energy security issues in their assigned countries," said Professor Kurtis Swope, Economics Department Chair and co-instructor of the course.

The course was also designed to expose students to high-level leaders in the energy security field. To achieve this end, prominent guest speakers included:

1. Assistant Secretary of the Navy for Energy, Installations & Environment Dennis McGinn
2. Colonel Jim Caley, director of the U.S. Marine Corps Expeditionary Energy Office
3. Mr. Paul Kolbe, director of international security affairs for British Petroleum

For More Information


FOR MORE INSIGHTS into Secretary McGinn's and Colonel Caley's perspectives on energy security, read our spotlight interviews in the winter 2014 and summer 2014 issues of *Currents* respectively. You can find these interviews and browse the *Currents* archives at the Department of the Navy's Energy, Environment and Climate Change website at <http://greenfleet.dodlive.mil/currents-magazine>.



Assistant Professor Joe Smith, co-instructor of the course from the Oceanography Department, organized a day-long session with energy security leaders at the Department of State.

“It was important for us to go beyond classroom discussions and expose our students to energy leaders who address these issues on a daily basis,” said Smith. “Our partners in the Pentagon and State Department were incredibly generous with their time.”

The final culmination of the course was a student-led poster presentation to faculty and Navy energy leaders.

“While the course took months of planning and long hours to implement, it was a tremendous success. The students gained insights that they could not have gained in the traditional single discipline class,” said Associate Professor Patrick Caton a co-instructor of the course from the Mechanical Engineering Department. “As a faculty member, I was energized by the collaborative experience and look forward to being part of the team again in the fall of 2016.” 

Karen Flack
United States Naval Academy
410-293-6501
DSN: 410-293-6501
flack@usna.edu

Tell Your Story in *Currents* • Deadline for Fall 2016 Issue is July 15, 2016

Have some good news about your energy or environmental program? Want to share it with others? *Currents* is the place to do it. *Currents*, the Navy's official energy and environmental magazine, has won first place in the Navy's Chief of Information (CHINFO) Merit awards competition three times. Most recently, the magazine snagged an honorable mention in the 2014 competition. Its people like you and the stories you submit that make *Currents* the best magazine in the Navy.

So if you have a story that you'd like us to promote in our fall 2016 issue, submit your text and images by Friday, July 15, 2016. Any submissions received after this date will be considered for our winter 2016-17 issue.

You can get a copy of the *Currents* article template by sending an email to Bruce McCaffrey, our Managing Editor, at brucemccaffrey@sbcglobal.net. This template has proven to be a tremendous asset in helping us edit and track your article submissions. Bruce is also available at 773-376-6200 if you have any questions or would like to discuss your story ideas. And don't worry. If writing isn't one of your strengths, we'll handle all of the editing necessary to get your submission into publishable form.

As a reminder, your Public Affairs Officer must approve your article before we can consider it for inclusion in the magazine.

Don't forget to "like" us on Facebook at www.facebook.com/navycurrents. *Currents'* Facebook page helps expand the reach of the magazine and spread the news about all the great work you're doing as the Navy's energy and environmental guardians.

Currents Deadlines

Fall 2016 Issue: Friday, July 15, 2016
Winter 2016-17 Issue: Friday, October 21, 2016
Spring 2017 Issue: Friday, January 20, 2017
Summer 2017 Issue: Friday, April 21, 2017

You can also refer to your *Currents* calendar for reminders about these deadlines.

Currents History of Awards

2014	Russell Egnor Navy Media Award	Honorable mention in "Funded News Publication" category
2011	CHINFO Merit Award	First place medal ("Best magazine in the Navy")
2008	CHINFO Merit Award	First place medal ("Best magazine in the Navy")
2004	CHINFO Merit Award	First place medal ("Best magazine in the Navy")
2004	Department of Defense Thomas Jefferson Award	First place medal ("Best magazine in the Department of Defense")
2003	CHINFO Merit Award	Second place medal
2001	CHINFO Merit Award	Third place medal

NAS Jacksonville Achieves Zero Wastewater Discharge

First Area Utility to Avoid Discharge into St. John's River

ON OCTOBER 15, 2015 Naval Air Station (NAS) Jacksonville became the first major utility in Northeast Florida to achieve zero discharge to the St. Johns River. The occasion was marked by a ribbon cutting attended by state, local, and Navy officials.

Not only has reuse of treated wastewater eliminated discharge into the river, it has also prevented the withdrawal of 73 million gallons of groundwater from the Floridan Aquifer every year—saving \$200,000 in annual fees for potable water—and has reduced the use of fertilizer on base grounds.

A History of Wastewater Reuse

NAS Jacksonville has a long history of reusing treated wastewater instead of discharging it to the St. Johns River. It all began in the late 1990s when the air station leadership agreed to divert thousands of gallons per day of treated wastewater to the nearby Timucua Country Club to irrigate its golf course. Representatives of the country club and NAS Jacksonville saw the opportunity to develop a tremendous environmental partnership that would benefit the river, groundwater,

and the long term operations of the golf course. In 1998, the station and club signed an agreement for the club to connect to the station's dechlorination system and divert approximately 200,000 gallons a day to irrigate its golf course. The country club paid all

costs for the design, permitting and construction of the reuse pipeline and retention pond, in exchange for receiving the water at no cost.

Bolstered by this success, NAS Jacksonville applied for a Florida Depart-



The zero discharge ribbon cutting ceremony was hosted by NAS Jacksonville Commanding Officer Capt. Howard Wanamaker (center) and attended by (from left): Jacksonville Mayor Lenny Curry, U.S. Representative Ander Crenshaw, Deputy Assistant Secretary of the Navy for Safety Paul Hanley, Commander Navy Region Southeast Rear Admiral Mary Jackson, St. Johns River Water Management District Governing Board Chairman John Miklos, and Florida Department of Environmental Protection Assistant Secretary Paula Cobb.

Clark Pierce

Not only has reuse of treated wastewater eliminated discharge into the St. Johns River, it has also prevented the withdrawal of 73 million gallons of groundwater from the Floridan Aquifer every year.

ment of Environmental Protection permit to expand its wastewater reuse system to its own 27-hole golf course and spray fields. The permit was received in 2004, and in 2007, NAS Jacksonville assisted the City of Jacksonville in obtaining a \$175,000 grant from the state to design the expansion. In 2010, the air station obtained a \$1.8 million Navy energy conservation grant for phased construction of a portion of the expansion.

In 2011, the station prepared another application for the City of Jacksonville to obtain a \$1.8 million matching grant from the St. Johns River Water Management District to construct the remainder of the reuse system expansion. The station completed its portion of the project with a two-mile, direct-bore purple pipe to a 10-acre reuse pond next to the NAS Jacksonville Golf Club in 2012. (Purple is the universal color for non-potable water in the state of Florida.) The city used a \$1.4 million district grant in 2014 to complete the final phase of the project to construct a two-mile pipeline and spray fields in the air station's South Antenna Farm area. The spray fields were designed as a method for distributing any wastewater not used by the golf courses with the benefit of irrigating this 47-acre expanse of unused land located between communication antennas. The spray fields are operated manually, and zones are rotated so as not to oversaturate any one particular area.

Once this final phase was complete, the air station reached its goal of zero discharge of all treated wastewater into the St. Johns River.

In early October 2015, the City of Jacksonville completed construction of two more miles of purple pipe to the spray fields at the southern area of the air station. This provided



U.S. Representative Ander Crenshaw (R-FL) (left) expressed his admiration for the zero discharge wastewater reuse project to former NAS Jacksonville Environmental Director Kevin Gartland (right). Gartland provided more than 15 years of leadership on the project.

Clark Pierce

nutrient-rich water to nourish and enhance this part of the base. On October 15, 2015 a symbolic valve was finally shut, signaling the end of discharge into the river.

Smart Landscaping

The station has also worked hard to conserve water through xeriscaping, or the selection of plants that require little or no supplemental watering once established. Native plants clean stormwater by removing dissolved nutrients that could otherwise contaminate the river. "All of our major construction projects use xeriscaping," says John Young, station stormwater manager. The base has installed such native trees as river birch, redbud, red maple, and bald cypress, as well as ground covers such as perennial peanut and ground mimosa, and ornamental native bunchgrasses such as Muhly grass and purple lovegrass.

"The grasses are great," says Young, adding that "they are a viable alternative to shrubs on many sites. We use them in all our biofiltration areas as well, so we get double use out of them—as green infrastructure to clean the water, and as landscaping."

This project is a great example of the significant value of working collaboratively on projects such as these, where the benefits are wide ranging and long term.

—Dr. Ann Shortelle



Stormwater Program Manager John Young shows off the “rain garden” at NAS Jacksonville. The pink Muhly grass, lovegrass, and bald cypress in this biofiltration area provide treatment for stormwater while also beautifying the installation.

Miriam S. Gallet



Native plants, being adapted to regional rainfall patterns, require no irrigation, allowing the station to leave a lot of water in the ground—roughly half a million gallons per year for utility applications alone—helping the Navy achieve its water conservation and quality goals.

Miriam S. Gallet


Along the same lines, NAS Jacksonville is testing a “Sustainable Landscaping Initiative” which proposes to turn some marginal mowed areas over to meadows of native grasses, such as Andropogon or broom sedge.

“The Andropogons grow about four feet tall,” says Young, “and form what looks like a wheat field, ‘amber waves’ and all.” The station has field-tested broom sedge and a variety of other natives, all grown from seed, on five sites and is considering ways to reduce the 1,200 acres of grass currently mowed. Young notes that meadows, with their taller and deeper-rooted growth, would only require mowing once a year in late fall, after the plants had set seed, and would reduce runoff and improve water quality. Additional benefits would include support of pollinators.

A Community Project

Since its inception, the wastewater reuse project has eliminated the discharge of more than 315 million gallons a

year of treated wastewater into the St. Johns River. At the same time, while it was being constructed, the system prevented the withdrawal of more than 44 million gallons of potable water from the Florida Aquifer.

The significant achievement was the direct result of NAS Jacksonville’s long-term environmental partnerships with multiple players from state, city and civic organizations—all working together to improve the water quality of the St. Johns River. In the words of Dr. Ann Shortelle, St. Johns River Water Management District executive director, “This project is a great example of the significant value of working collaboratively on projects such as these, where the benefits are wide ranging and long term.” 

Jay Caddy
Naval Air Station Jacksonville
904-542-6440
DSN: 942-6440
gerald.caddy@navy.mil

ESTEP Sponsors Effort to Protect Critical Data Infrastructures

Framework Underway to Secure Supervisory Control & Data Acquisition Networks

MANY EXPERTS HAVE become increasingly concerned about the potential for cyber attacks to negatively impact and possibly disable our nation's critical infrastructures, including the power grid. A new project, sponsored by the Energy Systems Technology and Evaluation Program (ESTEP), is working towards a solution.

Sponsored by the Office of Naval Research, the ESTEP program focuses on energy technologies that reduce costs, increase energy security, and ultimately increase the reach and persistence of the warfighter.

Securing SCADA Networks

A Supervisory Control and Data Acquisition (SCADA) network allows digital input from computing components, which might be thousands of miles away, to control physical assets (like motors, actuators, and pumps). While this allows for efficient management of infrastructure systems, there is a threat inherent in the unprotected nature, interconnected paradigm, and global footprint of SCADA networks. Because these networks could be extremely

vulnerable to security threats and cyber attacks, there are a number of technologies being developed to improve SCADA security. The Cyber-SCADA Evaluation Capability (C-SEC) project was formed to evaluate these technologies and develop a framework with which others can do the same.



The most well-known example of a cyber threat to date happened in Iran in 2010. A virus known as Stuxnet disrupted centrifuges at a uranium enrichment plant, and subsequently infected other computers in the country. A handful of malicious files—the world's first digital weapon—was able to operate for close to a year before being discovered, and has subsequently spread to many other parts of the world. Because the malware was signed by a digital

certificate to make it appear as though it had come from a reliable company, it rendered automated-detection software useless. Sophisticated malware such as this prompted the research and development of antiviral solutions.

The C-SEC project was formed to evaluate technologies for securing SCADA networks as they relate to energy systems and to integrate the best of these technologies into a new capability.

The main challenge facing the C-SEC team, headed by Jose Romero-Mariona of the Space and Naval Warfare Systems Center Pacific (SSC Pacific), is the fact that they are dealing with two opposing requirements—the necessity for SCADA networks to stay up all the time, and the security to ensure that there is no abnormal/malicious activity on them. Currently, there is no sure way to conduct an initial security scan of SCADA networks without the real possibility of system shut-down as a result of such scanning. This severely limits what we know today of our SCADA networks and what is in them.

The Cyber-SCADA Evaluation Capability project was formed to evaluate SCADA network security technologies and develop a framework with which others can do the same.

As the team began to evaluate SCADA security technologies, it became clear that they would need a laboratory environment where a sample baseline SCADA network (with real SCADA equipment and related hardware) could be utilized to explore current SCADA vulnerabilities. In this laboratory environment, the team tested various security technologies and assigned a numeric

score to each. The highest scoring technologies were incorporated into the C-SEC software tool to provide interested users with relevant information and results regarding security technologies available.

This software tool, which is now being perfected, allows for the streamlined evaluation of SCADA security technologies, including secu-

rity metrics, which can provide a detailed picture of how well current security technologies secure SCADA networks and their components. The software will identify any system shortcomings and provide recommendations on how to best secure it. This tool was developed using open-source software to enable wide use and reuse of the technology.

The Basics About the Energy Systems Technology & Evaluation Program

ESTEP FOCUSES ON energy technologies that reduce costs, increase energy security, and ultimately increase the reach and persistence of the warfighter. ESTEP seeks to identify viable emerging energy technologies, obtained for the most part from open-market sources and in-house government demonstrations. Technologies identified as promising by ESTEP will be demonstrated, and data will be collected to evaluate the performance and reliability of selected technologies under various environmental and operating conditions.

The entire program encompasses the following investment areas:

- Cyber and Energy Management for Information Systems
- Power and Energy Components
- Power and Energy Production/Efficiency



Established in fiscal year 2013, ESTEP casts a wide net across the Department of the Navy, academia, and private industry to investigate and test emerging energy technologies at Navy and Marine Corps installations. At present, ESTEP conducts nearly two dozen in-house government energy projects, ranging from energy management to alternative energy and storage technologies. Additionally, an ESTEP Broad Agency Announcement has awarded several contracts to industry in those same energy areas.

In addition to testing and evaluating performance and reliability of energy technologies, the ESTEP program provides mentoring (via on-the-job training and education of interns) and other workforce development opportunities by partnering with the Troops-to-Engineers program for veterans at San Diego State University and other universities. Workforce and professional development are key components of ESTEP and integral to the success of executing and transitioning energy technology projects at naval facilities.

ONR provides funding and oversight for ESTEP, and program management is being handled by SSC Pacific. The Naval Facilities Engineering and Expeditionary Warfare Center and the Naval Postgraduate School are executing selected research projects, and every project plans to involve at least one veteran intern utilizing an ESTEP grant to academic institutions.

For more information about ESTEP, contact Stacey Curtis at 619-553-5255 and stacey.curtis@navy.mil.



Another crucial part of this work involves the creation of a results database (or repository) where C-SEC evaluations can be shared among organizations within the Department of Defense. This sharing of results will provide information to bases and organizations that have similar systems, and will help standardize the way that these technologies are being evaluated. Information on costs and training technologies will also be included in this repository.

The team is currently building an app and lightweight environment, called “C-SEC On The Move,” to enable mobile devices such as smartphones and tablets to

leverage the C-SEC software and repository. This will enable any trained individual to utilize a light version of C-SEC software on the spot at any base or installation, thereby facilitating informed decision making.

The team is also conducting pilot training sessions to determine how best to deliver training on C-SEC and C-SEC On The Move. One session is tailored toward government scientists, and one is geared toward the warfighter. The warfighter training sessions are leveraging the Troops-to-Engineers program at San Diego State University.

Looking Ahead

Together, the C-SEC software and results repository will establish requirements and metrics for securing SCADA networks, which will benefit current and future security posture and will further integrate security considerations. C-SEC will also eliminate duplication of efforts in researching security technologies, thereby maximizing limited budgets, and increasing return on investment estimations.

Using C-Sec On The Move will enable the warfighter to select appropriate security technologies and conduct routine security scans bi-weekly or monthly, thereby achieving a level of cyber security not previously achievable. [↗](#)



An electric power dispatcher foreman operates the SCADA system at Commander Fleet Activities, Yokosuka, Japan. C-SEC software will enable such users to enhance the security of their SCADA systems.

Joe Schmitt

Jose Romero-Mariona
Space and Naval Warfare Systems Center Pacific
619-553-8119
DSN: 553-8119
jose.romeromariona@navy.mil

NESDI Program Launches Eleven Technology Initiatives

Notable Efforts Target Water Conservation Challenges & Enhanced Stormwater Monitoring

THE NAVY ENVIRONMENTAL Sustainability Development to Integration (NESDI) program launched 11 new initiatives in 2015 to address some of the most pressing environmental operational challenges facing the Navy. These projects range from efforts to better understand the potential impacts of water conservation measures on installation drinking water infrastructure, address the safe disposal and remediation of muni-

operations. In fiscal year 2015, after a total of 53 needs were collected, and 23 proposals were received and reviewed, the program gave the green light to the following 11 projects.

Project 524: Innovative Hydrant Flushing

Navy and Marine Corps installations worldwide are required to maintain a disinfectant residual in their drinking

nitrification or trihalomethanes (THM) may also build up in the water distribution system. (Nitrification increases nitrite and nitrate levels, and promotes bacterial regrowth.)

To maintain compliance, Naval bases flush hydrants with millions of gallons of potable water to eradicate stagnant water, clean the pipes, increase the disinfection residual in the pipes, and flush out the nitrates and THMs.

The flushing process wastes a tremendous amount of water—over a million gallons of water per year for one hydrant.

tions constituents, and improve the efficiency and effectiveness of stormwater monitoring systems.

Each year, the NESDI program collects environmental needs from across the Navy's shore community. Based on selected needs, project teams are formed to demonstrate, validate, and integrate innovative technologies, processes, and materials into fleet

water systems. The chlorine or chloramine residual prevents bacteriological growth in the drinking water and is required under the Safe Drinking Water Act (SDWA) and associated Chief of Naval Operations Energy and Environmental Readiness Division instructions. However, this chlorine residue tends to be "consumed" by a buildup of biofilms and sediment in most water systems. Additionally,

The flushing process can require a tremendous amount of water—over a million gallons of water per year for one hydrant. Not only is this expenditure of potable water wasteful in a severe and ongoing drought, but at some bases, the effective scouring velocity cannot be achieved by traditional hydrant flushing, even when done weekly. This means that nitrification can continue to occur despite the



massive outlay of water. This NESDI project was formed to find a solution to both problems.

The project team, headed by Tami Relph of the Naval Facilities Engineering and Expeditionary Warfare Center (EXWC), is demonstrating and evaluating a truck-mounted potable water distribution system to effectively perform hydrant flushing with no waste of potable water.

For scouring to be effective, a velocity of five cubic feet per second must be achieved. While conventional flushing typically produces a velocity of only one to three cubic feet per second, the high-velocity truck-mounted system chosen for the demonstration reaches the target five cubic foot velocity. Known as the Neutral Output Discharge Elimination System (NO-DES), the system has been used effectively in over 50 municipalities to date. It connects between two standard fire hydrants or between a fire hydrant and a fully open blow-off valve. The

water from the hydrant is run through a filter system mounted on the truck to remove biofilm and clean out the line. The truck system also disinfects the water and returns it to the water system, resulting in zero water waste.

To demonstrate the NO-DES system, the drinking water system at the Navy Base Ventura County (NBVC) Port Hueneme base will be flushed. NBVC is a typical Navy installation where conventional hydrant flushing has shown to be ineffective. Water quality parameters will be collected before, during and after flushing to determine the system's effectiveness. Additionally, the base will be monitored for nitrification and chloramines for one year. At the end of this period, an economic analysis will be conducted to compare the costs of purchasing the equipment versus contracting for the flushing service as a better option to conventional hydrant flushing.

At the conclusion of the project, the NO-DES system will be demon-

strated to selected potential users. The team will also prepare a video of the system in use, so that Navy public works directors can see the ease with which the system is set up and utilized.

Project 518: Impacts of Low Water Flows on Sewer Systems

Widespread mandated water conservation measures have resulted in reduced and concentrated flow through wastewater collection systems. While this is in itself an accomplishment, there is an unknown aspect of conservation that requires further study.

The NESDI program identified a need for the Navy to understand, assess, and address the impacts of water conservation measures on installation water and wastewater infrastructure. Because installation collection and distribution systems were designed for much higher flow rates, little is known about the impact of low



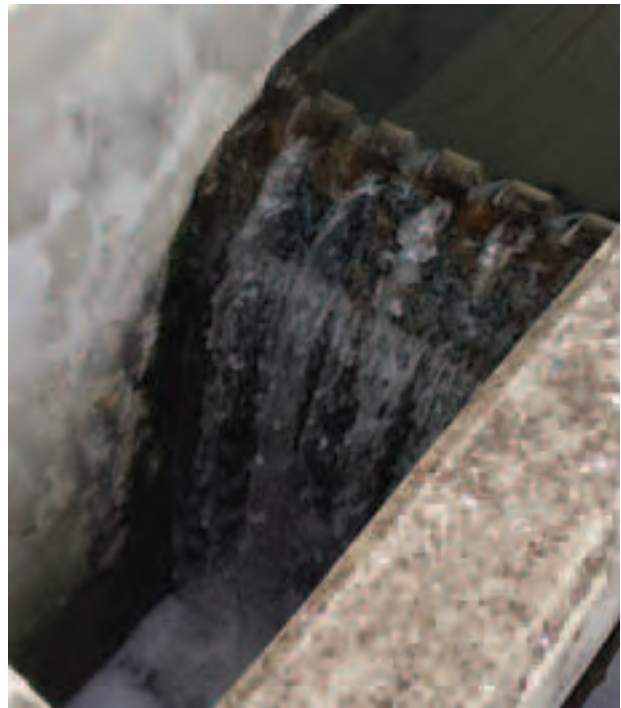
This wastewater treatment plant is designed for an average daily flow of 107,000 gallons per day. This image was taken during a time of low flow into the plant and shows the incoming sewage flowing through two bar screens, and finally into a Parshall flume where the flowmeter records the flowrate of the influent wastewater.

Tami Relph

wastewater flow on these systems. Potential problems could include increased corrosion in lines, elevated levels of hydrogen sulfide (a threat to sanitation workers in confined spaces), more frequent blockages, and increased concentrations of unhealthy contaminants.

This project, also headed by Tami Relph, was formed to determine whether such impacts are occurring, and if so, to recommend measures to overcome them.

The first phase of the project will include data collection from a significant portion of the Navy-operated systems and a select number of similar municipal systems, along



Outfall for the same wastewater treatment plant. The treated wastewater effluent discharges into a combined sewer line after chlorination.

Tami Relph

with detailed investigations of problem systems. The team will ask for data on flow rates, total suspended solids, nitrogen, Biological Oxygen Demand, and sulfur concentrations. These data are regularly collected for other purposes and therefore should be readily available. The project team will also collect data on Notices of Violation (NOV) as well as qualitative information from installation water program managers and the Water Media Field Team. This would include such data as increased odor, lift station blockages, higher hydraulic detention times, and increased grit loads after heavy rain due to low flow periods. Once these data are collected, they will be compiled into a spreadsheet to help identify problem issues that correlate with low flow conditions.

If no significant problems are identified, a final report will be prepared and the project will be terminated. If problems are found, the project team will gather additional information on the issues (such as additional laboratory analysis not normally performed by the Public Works staff) and will identify potential Best Management Practices (BMP) to address those issues. If an appropriate technology is identified that addresses a key problem with reduced flow rates in sewers or treatment plants, a limited duration demonstration may be recommended for future NESDI funding.

Aggressive water conservation strategies can reduce both facility and irrigation consumption rates.

Project 528: Impacts of Water Conservation Measures on Drinking Water Quality

Another project is addressing the need for the Navy to understand, assess, and address the impacts of water conservation measures on water infrastructure—specifically on drinking water systems.

Navy installations commonly struggle to maintain residual chlorine levels without exceeding the total THM standard at the far reaches of distribution systems. The levels of THMs and other byproducts of chlorination tend to increase with the amount of time water remains in a system, and when less water is used, this time period tends to lengthen.

To date, there has been no comprehensive trend analysis that demonstrates how water conservation efforts may contribute to the deterioration of drinking water quality. It is the goal of the project to assess a representative sample of drinking water systems to gain a better understanding of the impact of declining consumption on these systems.

There are a number of fundamental characteristics of drinking water supply systems common to many Navy facilities that may impact SDWA compliance:

- Low density land use planning strategies can lead to relatively long distribution

runs between the supply system complex and the buildings it is designed to supply.

- Declining staffing levels can lead to reductions in total water demand.
- The capacity of aging water systems that were originally oversized to provide for fire flows can provide space for water to stagnate.
- The roughness of existing piping materials can allow for and even encourage development of biofilms (biomass).
- Aggressive water conservation strategies can reduce both facility and irrigation consumption rates.
- Regulatory standards that address water quality within the distribu-

tion system are becoming increasingly more rigorous.

Though this project will concentrate on the impacts of water conservation efforts, it will also identify operational, systemic or long-term policy changes that would minimize compliance problems. This will include an analysis of the current method for flushing and cleaning pipes discussed under the “Innovative Hydrant Flushing” project previously discussed. Additionally, the project team will assess trends in an attempt to more accurately evaluate future regulatory challenges that should be considered by drinking water system planners.

In the first phase of the program, the team, headed by Prakash Temkar of EXWC, will gather a representative



This project is studying the impact of declining consumption on drinking water systems.

Photographer's Mate 1st Class Bart A. Bauer

sample of drinking water system characteristics, examine NOVs, identify system problems, and define the current state of the practice. Representative case studies will be developed based on observed “real world” systems and problems.

Next, the project team will engage a group of Navy drinking water system experts to analyze specific systems and problems and recommend alternative strategies to address these problems. The team will then conduct a table top analysis of existing system designs including current water consumption rates and associated water conservation efforts.

Finally, the team will analyze specific recommended strategies based on anticipated benefit, cost, and potential risks. The team will also attempt to identify and evaluate operational BMPs, low-cost structural BMPs, and systemic (long-term) BMPs.

flow duration and magnitude), and contaminant loading to the receiving waters. The result is expensive data collection efforts that provide little information on the impact to the receiving waters. Additionally, when these limits are exceeded, the violations invariably require the implementation of BMPs that may not be effective or even appropriate.

This project, headed by Gunther Rosen of the Space and Naval Warfare Systems Center Pacific (SSC Pacific), will evaluate the effectiveness of using passive sampling devices (PSD) to assess the impacts of stormwater runoff and improve stormwater management. Passive sampling, as part of an integrated monitoring plan, shows great potential to provide the needed data.

Typically, stormwater monitoring consists of many components including:

Since the PSDs used in this project consistently sample over time, they automatically provide a time-integrated measure of contamination without extensive sampling and analysis costs. PSDs can provide meaningful data which are more representative of the potential for biological effects, because they will record time-varying exposure of contaminants released over time.

The project team will work with partners at Naval Base Kitsap (NBK), Naval Facilities Engineering Command (NAVFAC) Northwest, and the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) to integrate PSDs into their current stormwater monitoring efforts. Representative drainage basins will be selected that cover the range of land-use/land-cover and industrial activities present at NBK. Priority will be given to basins slated for installation of

PSDs can provide meaningful data which are more representative of the potential for biological effects.

Project 523: Stormwater Monitoring with Passive Sampling

A system for monitoring stormwater runoff is required by all Naval facilities as part of their National Pollutant Discharge Elimination System permit. Currently, stormwater monitoring is labor intensive, expensive, and not optimal for meeting regulatory requirements. Regulatory agencies are currently requiring an arbitrary monitoring schedule (monthly or seasonally) that ignores the driving forces within the watershed such as hydrology (e.g.,

- Identifying representative sampling locations.
- Establishing telemetry and data sensors for flow, conductivity/salinity, and turbidity.
- Installing rain gauge stations.
- Collecting manual grab and automated composite samples at specified locations).

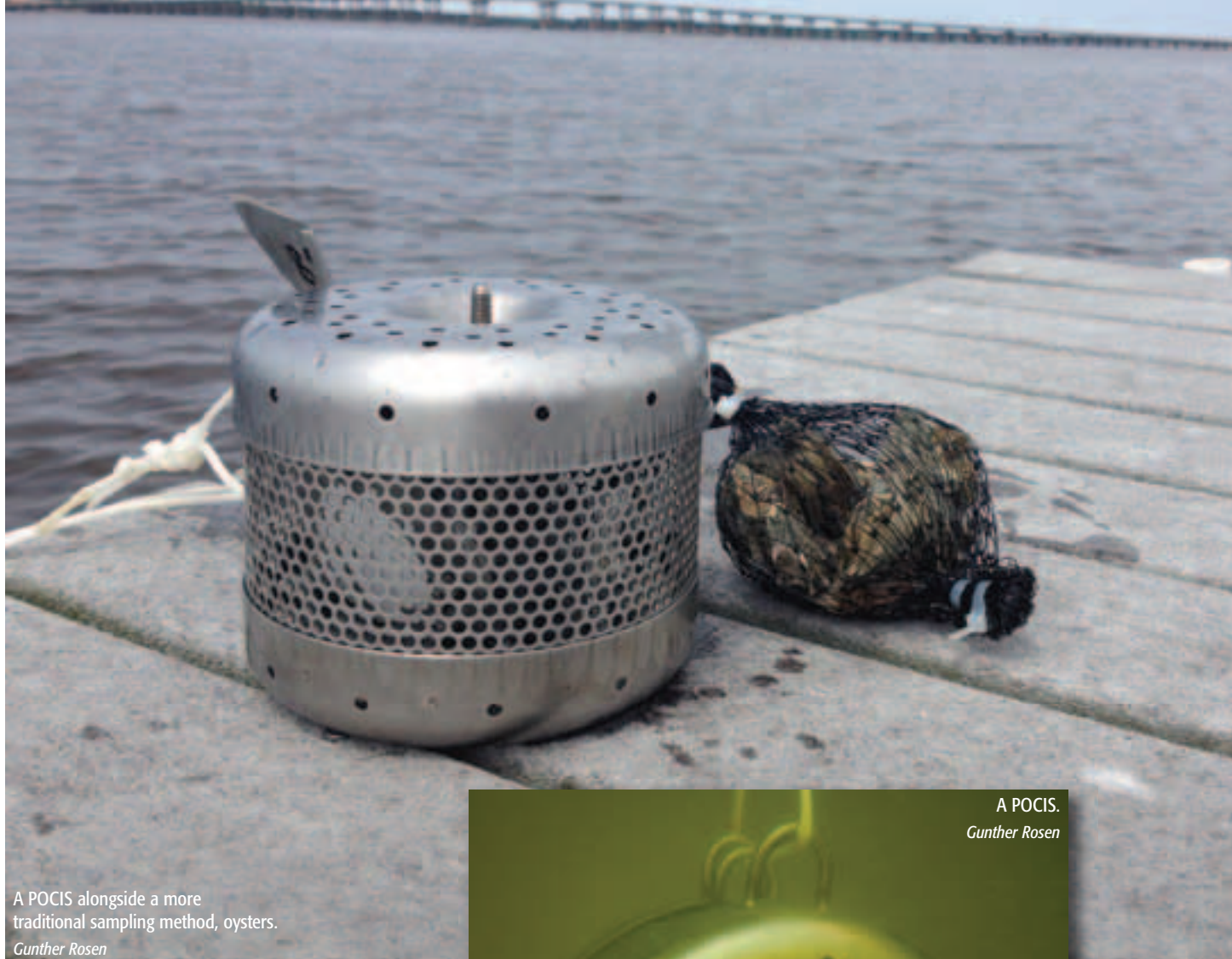
However, these data are unable to provide information about pulsed (intermittent) inputs of contaminants into the receiving waters.

BMPs or other stormwater improvement projects so that before/after effectiveness can be evaluated.

This project will demonstrate two different types of passive samplers:

1. Diffusive Gradients in Thin Film (DGT) for metals
2. Polar Organic Chemical Integrative Samplers (POCIS) for contaminants including compounds that occur in human waste and wastewater

Over 300 chemicals have been calibrated for quantification by POCIS. This project will measure selected



A POCIS alongside a more traditional sampling method, oysters.
Gunther Rosen



A POCIS.
Gunther Rosen

organic marker chemicals found in human waste and wastewater including pharmaceuticals, hand sanitizers, fragrances, and others. Indicators of human waste to be sampled by POCIS will be selected based on site expectations to improve detectability near expected waste sources and to decrease false positives due to alternative sources that may be present on site (i.e. bird fecal material).

The DGTs will be deployed for multiple time points (days, weeks, months) to characterize the pulsed nature of metal exposure during storm events, and spatially to verify mixing of stormwater with the receiving environment.

Performance will be evaluated based on the cost and ability for the PSDs to provide meaningful data with which to quantify the effectiveness of BMPs and stormwater management programs.

This project will be conducted in coordination and collaboration with the Puget Sound Ecosystem Monitoring

Program (PSEMP) Stormwater Work Group which is working with local, state and federal jurisdictions to develop a regional stormwater monitoring program, and the PSEMP Toxics Work Group which is assessing the impact of toxics on the Puget Sound ecosystem. The work will help expand the PSEMP's effort to include Navy facilities regulated by the U.S. Environmental Protection Agency (EPA) and address monitoring and BMPs for industrial sites.

The project will also leverage with a recent Environmental Security Technology Certification Program (ESTCP) project conducted at SSC Pacific. In this effort, DGTs are being integrated into a stormwater monitoring assessment strategy at Naval Base San Diego (ESTCP project #ER-201130) led by Gunther Rosen and a newer Strategic Environmental Research and Development Program (SERDP) project (#ER-2428), led by Danny Reible and SSC Pacific researchers, with a focus on stormwater contamination on sediments at Naval Base San Diego.

Successful completion of this project will make a major contribution to the watershed-based approach for stormwater management recommended by the National Research Council and assure that the Navy is adequately represented within the stakeholder groups.

Project 519: Analysis of the Long-Term Fate of Munitions Constituents on Terrestrial Sites

The Navy has approximately 325 terrestrial munition response sites where munitions or munitions constituents (MC) from unexploded ordnance and discarded military munitions are found and need to be remediated. While the fate and transport of the more common MCs such as TNT (2,4,6-trinitrotoluene) and RDX (cyclotrimethylene-trinitramine) in the environment are relatively well known, there are many associated degradation products and compounds (e.g., picramic acid) that form as the MCs degenerate. The fate, transport, and toxicity characteristics for these products are unclear, which hampers the development of viable risk assessments at impacted sites.

While site managers may be able to find some of the necessary information through literature searches, there is no one easy reference that captures this information in a concise format. This project was formed to identify, research, and summarize the current knowledge about the fate, transport, and toxicity characteristics of MC and associated degradation products found at terrestrial munition response sites. Information developed under previous SERDP and ESTCP efforts will be reviewed for applicability.

This project team, headed by Jim Austreng of EXWC, will develop a list of degradation compounds associated with each targeted MC. Factors such as fate (degradation behavior), transport (chemical and physical properties), and toxicity data for each compound will be covered as well as regulatory limits for the MC and degradation compounds, and a discussion of applicable remediation technologies. These data will be compiled into an Initiation Decision Report (IDR) that will identify gaps in the data as well as critical assessments of those gaps to aid in developing a remediation strategy.

The IDR will be available to Navy decision makers including Remedial Project Managers (RPM) via various channels including postings on websites and webinars. The report will enable them to survey the current state of knowledge about the fate, transport, and toxicity of MCs and to understand how specific targeted investments could enhance capabilities to respond to the associated risks. The summaries and assessments in the IDR may later be transferred to end users with similar responsibilities for other armed service branches.

The data in the IDR appendix can be used by RPMs, contractors, and opera-



Discarded military munitions.

Boat targets are often stockpiled until they can be inspected, taking up valuable space and interfering with day-to-day operations.

tional range personnel for addressing regulatory concerns about MCs and MC degradation products at terrestrial munition response sites and operational ranges.

Project 526: X-ray Inspection for Demilitarizing Boat Targets

The Navy has significantly increased training exercises that use small boat targets. Trainees fire tracer rounds at

these targets, some of which become lodged in the targets themselves. When training is concluded, all targets are regarded as Material Potentially Presenting an Explosive Hazard (MPPEH) and must be certified as inert before disposal. This means the target must be free from all projectiles and be visually inspected by an Unexploded Ordnance Technician to certify it is Material Documented As Safe

(MDAS) before it can be disposed of. Currently, this is a time-consuming process, and boat targets are often stockpiled until they can be inspected, taking up valuable space and interfering with day-to-day operations.

The Naval Air System Command (NAVAIR) Seaborne Targets program has an urgent need for a means to clear its targets as safe for repair and disposal following live fire operations.

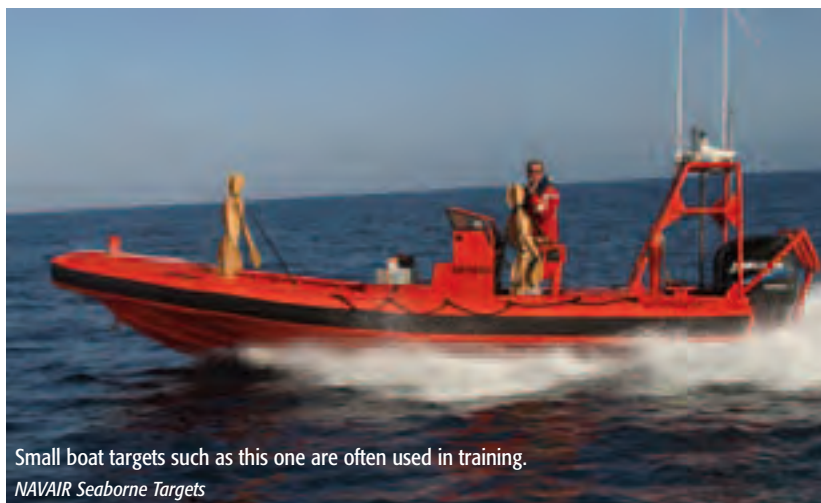
To serve this need, Principal Investigator Joey Trotsky (from EXWC) and his team is demonstrating a hand-held X-ray device that would allow inspectors to determine whether or not boat targets contain MPPEH. These machines have been recently developed for use in the dental and medical fields as well as for law enforcement to use on suspicious bags and vehicles. These hand held systems produce an easy-to-read image of the scanned object. If no projectile is found, the target can be immediately classified as MDAS. If MPPEH is found, minimal cutting and digging can be conducted to certify the material as safe for disposal.

Two different machines will be demonstrated at the NAVAIR Seaborne Targets Facility in Port Hueneme, California. Evaluation of the technology will include determining if the X-ray image will accurately show the locations of projectiles, the amount of time needed for a complete scan of the target, and the ease of use.

The new technology will be immediately available for use at the



A boat target with mannequin.
NAVAIR Seaborne Targets



Small boat targets such as this one are often used in training.
NAVAIR Seaborne Targets

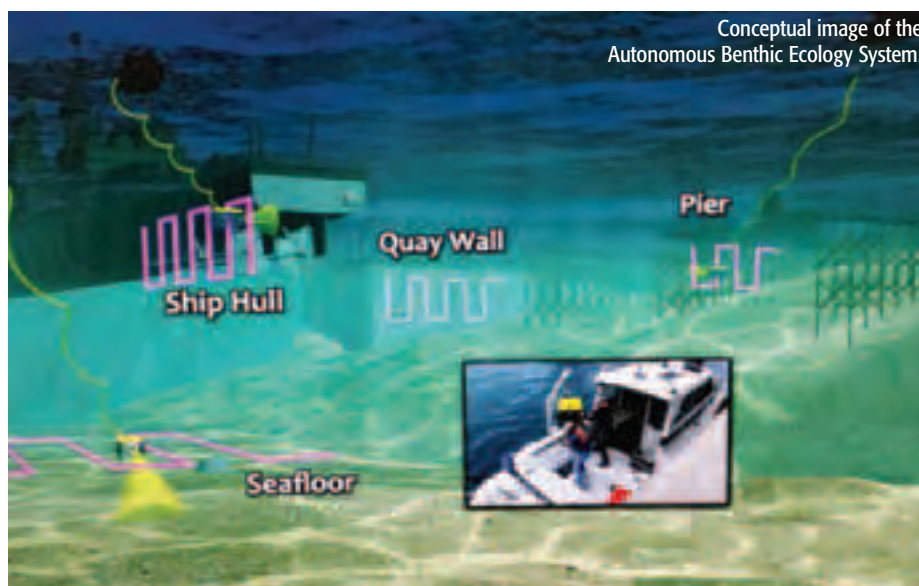
Seaborne Targets Facility once it is successfully demonstrated. The ability for onsite personnel to classify a target as MPPEH-free will allow the prompt removal of the object to the Defense Utilization and Reissue Office, freeing up valuable storage space.

Project 521: Autonomous Benthic Ecology System

In order to comply with environmental directives, such as the National Environmental Policy Act (NEPA), the Navy needs the ability to conduct close, high-resolution monitoring of threatened and endangered species within coral reef communities and other benthic (seabed) ecosystems. This need became even more urgent in 2014 with the addition of 20 coral species to the Endangered Species List.

One way to effectively survey these areas is to create a photomosaic, or a collection of individual high-resolution images of each ecosystem. This technology was developed under an SERDP project, and demonstrated and validated under ESTCP funding.

The current approach to conducting photomosaicing surveys is to hire contract divers for months at a time to assess these areas in small sections or to assess small random areas and overestimate ecological metrics with statistical analyses. This is very costly and time consuming, and the data generated may not meet regulatory compliance under NEPA. Additionally, these surveys are currently conducted by various methods and entities, making data usability and comparability difficult.



Conceptual image of the Autonomous Benthic Ecology System.



Corals on Japanese Finger Pier, Apra Harbor, Guam.

Utilizing a remotely operated vehicle (ROV) to conduct underwater surveys would present a complete picture of the benthic community because these vehicles can travel into areas that are inaccessible, such as vertical structures, or dangerous for divers to access, such as areas with suspected unexploded ordnance.

This project, led by Cheryl Cooke of SSC Pacific, will develop and test an Automated Benthic Ecology System (ABES) for the purpose of conducting such surveys at sea ranges, vessel homeports and weapons test and evaluation centers. The system will leverage a previously developed sensor-based stabilized ROV which has been demonstrated for identification of waterborne improvised explosive devices. This ROV will be equipped with photomosaicing cameras as well as other sensors to capture parameters including pH, salinity, and temperature. The ABES will be able to traverse vertical structures such as piers and quay walls, and can safely survey areas with known or suspected unexploded ordnance. The vehicle will also prove useful in examining underwater surfaces for cracks or damage, including piers and ship's hulls.

In the first year of the project, the ROV will be equipped with the cameras and sensors. Next, the team will conduct tests to verify the vehicle's stability and agility, the accuracy of the results, and the kind of environmental disturbances the vehicle can handle. In year two, the team will test the integrated system in the ocean environment at a pier on San Clemente Island. This site offers a plethora of benthic environments to assess, including piers covered with fauna.

The final test will be a field study at Naval Air Station Key West.

Two seawalls and a coral reef will be surveyed, and photomosaics of the pier wall will be made in the San Diego laboratory. This will determine whether or not the ABES is effective in extracting the data required by the Florida Keys National Marine Sanctuary, and to a greater extent, whether the system will be viable for compliance purposes at other sites.

A report will be generated documenting the suitability of the photomosaicing technology for compliance documentation. The report will contain the results of the field testing along with Graphical Information Systems maps for easy incorporation into environmental compliance documents of all types.

Project 522: Enhanced Monitored Natural Recovery for Sediment Remediation

Contaminated sediment in the Navy's harbors is anticipated to become a one billion dollar problem over time;

more if potential natural resource damages are factored in. The most common current remediation techniques are dredging, capping and natural recovery—but all three methods have associated problems.

Dredging is very costly and may result in collateral impacts to aquatic biota, along with resuspension and resettling of contaminants. Capping, which involves covering submerged contaminated sediments with layers of sediment, gravel, and/or synthetic materials, is relatively less costly, but is not always possible in harbors with substantial ship traffic. Monitored natural recovery, while cost effective, is not always acceptable to regulators and public stakeholders, largely because it takes a large amount of time, and results can be unpredictable. Driven by a lack of suitable options and the increasingly apparent limitations of existing technologies over time, there is a need to develop more nuanced technologies and risk assessment methods.



This project team plans to apply its field testing results at pilot scale at a Navy harbor in Puget Sound.

MC Seaman Apprentice William Blees

Cost effectiveness could also be significantly enhanced by integrating EMNR with opportunistic beneficial reuse of clean dredge sediments.

One of these methods is Enhanced Monitored Natural Recovery (EMNR). In this approach, thin caps (10-30 centimeters) of clean sediment are placed atop contaminated sediment to enhance ongoing natural recovery processes. In contrast to the thicker layers of sediment used in traditional isolation capping, thin caps used for EMNR are not intended to provide a complete seal over the contaminated sediment. Instead, they simulate an accelerated natural deposition of clean sediment, resulting in a surface layer of cleaner sediment and an immediate reduction in surface contaminant concentrations. This facilitates the reestablishment of benthic (bottom dwelling) organisms, and accelerates the processes of natural binding and physical isolation that would occur over time. True EMNR

also lends itself well to beneficial reuse of clean dredge materials, and it is cost-effective. However there are few examples of true EMNR implementation in the U.S.

Previous EMNR efforts have been reviewed and summarized in an ESTCP project (#ER-201368) conducted by this project's Principal Investigator, Victoria Kirtay of SSC Pacific. These efforts utilized sand as the capping layer instead of local sediments or sediments with an appreciable organic content, and therefore have little or no binding capability.

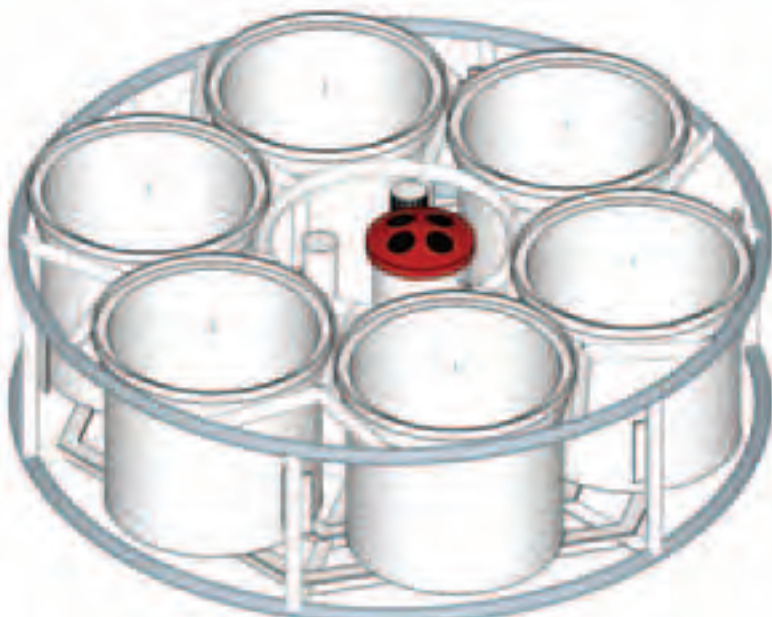
The key focus of this project is the development of standardized procedures for applying EMNR using natural sediments at moderately contaminated Department of Defense (DoD) and Navy sites.

Currently, the project team is defining key EMNR parameters and protocols, to ensure that the methodology can be replicated elsewhere. Then a range of natural sediments will be field tested using a Remedy And Recontamination Assessment (RARA) array that the project team is developing under ESTCP and SERDP funding. Next, the team plans to take the field testing results to application at pilot scale at a Puget Sound Navy site. This effort, leveraged with ESTCP funding, will include application of the protocols developed under this project, and potentially, integration with opportunistic beneficial reuse of clean dredged sediments. The scale of the demonstration will be tailored to the specific conditions and requirements of the chosen site, and constrained by the available funding. Performance and cost metrics will be captured for comparison to current capping methods and other sediment remedies.

EMNR technology, when implemented with natural sediments, promises to be both more successful and more cost effective than current approaches. Cost effectiveness could also be significantly enhanced by integrating EMNR with opportunistic beneficial reuse of clean dredge sediments.

Project 527: Structure-function Relationship of Perfluorochemicals from AFFF

Perfluorochemicals and polyfluorinated alkyl substances (PFAS) are chemicals that have been widely used for



Sediments will be tested using a RARA array that is being developed for a SERDP project. This diagram shows an isometric view of the RARA with sediment trays and instruments installed.



Sailors test an AFFF hose during a Board of Inspection and Survey.

Photographer's Mate 3rd Class Robert M. Schalk

decades, both in consumer products and industrial processes. PFASs are unique in that they possess both hydrophobic (water-repelling) and oleophobic (oil-repelling) properties, making them especially useful in fighting fuel fires. The Navy and the other DoD services have used significant quantities of PFASs in the form of aqueous film-forming foams (AFFF) for fighting petroleum fires since the 1960s.

Despite their effectiveness, PFASs are defined as an emerging contaminant by the DoD. PFASs have been shown to cause developmental problems, have been implicated as immune-suppressants, endocrine disruptors, and some are classified as probable carcinogens. In addition, they are

environmentally persistent due to their strong fluorine-carbon bond, are bioaccumulative, and have been detected in environmental samples long after a release was reported.

AFFFs are stockpiled and used in regular training exercises and emergency responses by fire departments throughout the DoD. AFFFs and their PFAS components represent one of the greatest emerging contaminant challenges facing the Navy's environmental restoration program, partly because the current understanding of their fate and transport in soil and groundwater is limited.

This project, headed by John Kornuc of EXWC, was formed to gather more information about these contaminants, and to develop a conceptual site model for Navy sites impacted by PFASs from various sources, especially AFFF.

PFASs are based on hydrocarbon chemicals where the hydrogen atoms in the carbon-hydrogen bond have been completely (perfluorinated) or partly (polyfluorinated) replaced by fluorine atoms. There are hundreds of PFASs, and analytical methods have only recently become available to accurately measure the major PFAS compounds of AFFF formulations used by the DoD. As a result, it has only recently become possible to conduct a full characterization of PFASs associated with AFFF use, and identify the various compounds and their behaviors/presence across a site.

The project team will begin by reviewing available data from 15

Navy and Base Realignment and Closure (BRAC) sites impacted by PFASs. The PFAS data will be closely inspected to identify preliminary trends and behavioral indicators. Factors such as nature of sources, distance of plume migration from its source, hydrogeology, and potential receptors will be compiled. This information will be combined with a literature review to develop preliminary indicators of fate and transport of the chemicals.

In the second phase of the project, three sites will be selected that have likely source zone areas and/or a plume that has migrated to potential surface water receptors. The authors will perform multi-level sampling at these sites, including sampling of surface sediment and benthic invertebrates. Utilizing this information, the project team will develop a decision tool with the ability to inform site managers and RPMs and enable them to make effective site management decisions when PFASs are present at their sites.

Project 525: Finding a Safe, Effective Alternative to Isocyanate Aircraft Coatings

For many years, polyurethane topcoat materials have been used for maintenance of military aircraft because of their superior abrasion-, stain-, and chemical-resistant properties. However, these products contain isocyanate compounds, which are regulated by the EPA as a hazardous air pollutant and a

AFFFs and their PFAS components represent one of the greatest emerging contaminant challenges facing the Navy's environmental restoration program.



Worker applying polyurethane coating to an F/A-18 aircraft.
Jennifer Nunez

The focus of this project is to validate mature products for both touch-up and full aircraft application.

hazardous waste. Because they pose a threat to human health, painters are required to wear personal protective equipment (PPE) and undergo medical monitoring when applying these formulations. Additionally, regulations require that the entire aircraft be roped off during spray applications of polyurethanes, thereby preventing concurrent work in nearby areas.

This project was formed to find a non-isocyanate formulation so that the Navy can minimize or eliminate the environmental hazards and health risks associated with currently used polyurethane products.

The Naval Research Laboratory (NRL) has recently developed two siloxane-based topcoats for Navy surface ships.

Siloxane (also referred to as polysiloxane) polymers offer several advantages over organic-based isocyanate compounds, such as those used in polyurethane topcoats, due to the inherent chemistry of the materials. Siloxane materials have greater exterior durability (e.g., color stability) and thermal stability due to an increased resistance to UV/sunlight and heat. And because siloxane-based polymers are lower in viscosity, less solvent is needed to formulate a coating product. Siloxane is used in many consumer products and is relatively non-toxic and non-flammable.

The novel one-component and two-component siloxane products developed by the NRL are undergoing demonstration and qualification on

two Navy surface ships and both are currently outperforming all qualified ship topside coatings. A concurrent ESTCP project is developing aircraft topcoats based on polymers used in the NRL coating formulations.

The focus of this project, led by Jennifer Nunez of the Fleet Readiness Center (FRC) Southeast, is to validate mature products for both touch-up (single component) and full aircraft application (two-component). Products will be tested for compatibility with existing aircraft finishing materials and non-chromate containing primer systems. Following compatibility testing, the coatings will be performance tested for adhesion, gloss, weatherability, flexibility, fluid resistance and heat resistance. Strippability

studies will also be performed to ensure siloxane systems can be fully integrated into FRC overhaul cycles. These tests will be performed at laboratory scale utilizing materials, equipment and facilities representative of industrial environments at NAVAIR FRCs. The criterion for success will be performance equal to or better than traditional polyurethane coatings qualified to military specifications MIL-PRF-81352 and MIL-PRF-85285. Due to the level of maturity, single component validation will occur first. Two-component systems will be validated within three years of project start.

Implementation of the new product(s) will occur through development of engineering documents to include use of siloxane coating for aircraft and components. Demonstration results will enable adoption of the technology throughout Level III FRCs through NAVAIR authorization and the development of Local Process Specifications that control processing requirements, materials utilized and quality conformance inspection. In addition, the siloxane coating technology will be added to the Authorized Use List at each paint shop in the desired application. FRC artisan training will also be provided based on the application optimization results.

Project 520: Quantification of PCB Paint Volatilization

The use and manufacture of paint containing polychlorinated biphenyls (PCB) has been prohibited for decades. Some Navy ships however, still have

PCB-containing paint that was applied before use of this type of paint was prohibited. Because PCBs are known to become volatile (airborne) when heated, special measures must be taken when these ships arrive at the shipyard for welding and cutting operations. Current procedure requires the removal of PCB-containing paint up to a radius of 24 inches when performing work that has the potential to heat the steel in excess of 200 degrees Fahrenheit. However, there is a lack of data showing the quantity of specific PCB components volatilized as a function of temperature, and these controls may well be overly conservative.

This 24-inch removal requirement results in increases in time and cost to perform the required work, and generates a large volume of waste that needs to be safely disposed of.

Additionally, the risk of safety issues for employees as well as injuries from chronic exposure to noise and vibration is elevated.

Currently, this problem is of great importance at PSNS&IMF due to the large volume of current and planned inactivation and recycling of Navy vessels. Other shipyards and maintenance facilities performing work on ships with legacy paint systems could also be impacted.

This project will investigate the volatilization rate of paint containing PCBs in order to generate a defensible, environmentally and fiscally responsible work process for the removal of paints containing these compounds.

The team, led by Patrick Morrow of the Naval Surface Warfare Center Carderock Division, will perform a thorough quantification study to



This NESDI project will investigate the volatilization rate of PCB-containing legacy paints on Navy ships.
MC Seaman Apprentice Robert Robbins



The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shore-side (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by NAVFAC out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to ESTCP which conducts demonstration and validation of technologies important to the tri-Services, EPA, and the Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil.



relate steel temperature to volatilization of PCBs within various paint systems. The study is based on standard EPA test methods, and will be carried out by accredited laboratory facilities. Samples of PCB-containing paint will be taken from a ship at PSNS&IMF and heated to a range of temperatures up to 400 degrees Fahrenheit in a controlled environment. The vapor phase during this heating process will be collected on low-volume polyurethane foam (PUF). This vapor phase testing will be conducted by scientists at the Naval Air Warfare Center China Lake, and the resulting PCB-bearing PUF samples will be sent to an outside laboratory competent in PCB extraction and analysis. The results of this analysis will show the total loading of PCBs resulting from exposure at different temperature levels. These data can then be correlated to available steel heating profiles developed at PSNS, enabling informed decision making, and the appropriate modification of current work processes.

The final product of this demonstration will be a work process that relates the paint removal requirements with

paint type, thickness, and task to be completed. This process will be based on a statistically valid correlation of the loading of PCBs released into the atmosphere as a result of heating the paint to various temperatures corresponding with cutting and welding operations.

For More Information

One-page fact sheet summaries of all NESDI projects are available on the program's web site. No username or password is required to access them. Visit www.nesdi.navy.mil then select "Projects." You'll see a list of projects with the most recent efforts at the top of the list. Click on the "Fact Sheet" link in the "More Information" column for more details. Browse the "More Information" column to find additional links to project-related final reports, videos and *Currents* articles. [↕](#)

Ken Kaempffe
Naval Facilities Engineering and Expeditionary Warfare Center
805-982-4893
DSN: 551-4893
ken.kaempffe@navy.mil

ONE OF MY Best Shots



I took this photo off of Gab Gab Beach in Guam while I was searching for long-spined sea urchins (*Diadema spp.*) around the island. The small blue fish are juvenile Damsel Fish (*Chromis spp.*), the small blue spotted fish are Filefish (*Oxymonacanthus spp.*), and the coral are Staghorn/Elkhorn coral (*Acropora spp.*).

Although not in this photo, we did observe large numbers of long-spined sea urchins, which is significant since they are culturally important to the Chamorro people (the indigenous people of Guam) and are known to be relatively sensitive to contaminants including copper and nickel.

My Space and Naval Warfare Systems Center Pacific colleagues and I were tasked by the Naval Facilities Engineering Command Marianas to support the development of site-specific water quality objectives for the region. This work included generating toxicity data for copper and nickel using important and sensitive species that reside in the nearshore areas around Guam. These data were integrated into a comprehensive science-based strategy for wastewater discharges to Tipalao Bay, which is under consideration by the Guam Environmental Protection Agency and the U.S. Environmental Protection Agency Region IX.

I took these photos with a Nikon COOLPIX AW100 at an F-stop of 3.9.

Gunther Rosen ● Scientist ● Space and Naval Warfare Systems Command ● rosen@spawar.navy.mil

Submit your own Best Shot to Bruce McCaffrey ● *Currents'* Managing Editor ● brucemccaffrey@sbcglobal.net

Kenneth Hess
CNO Energy and Environmental Readiness Division (Code N45)
2000 Navy Pentagon, Room 2E258
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